

# *The Mysterious S Curve*

4<sup>TH</sup> Edition, November 2018



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## 1.0 Introduction

The first time most Project Managers become aware of the existence of S Curves is when they are requested by their Client or Senior Management to include S Curves in their next Progress Report. The purpose of this White Paper is to explain what S Curves are, how they are generated, why they are an important Project Management tool, and how to use S Curves to analyse a Project.

## 2.0 What is an S Curve?

An S Curve is defined as:

*"A display of cumulative cost, labour hours, or other quantities plotted against time. The name derives from the S-like shape of the curve, flatter at the beginning and end and steeper in the middle, which is typical of most projects. The beginning represents a slow, deliberate but accelerating start, while the end represents a deceleration as the work runs out".*

**Source:** Wideman Comparative Glossary of Common Project Management Terms v2.1 Copyright R. Max Wideman, May 2001

## 3.0 Types of S Curves

An S Curve is graphed on an X-Y graph with the X axis representing time, and the Y axis representing a quantity, usually Man Hours or Cost. The three basic types of S Curves this White Paper will cover include:

### Baseline S Curves

- These S Curves are generated from the Baseline Schedule and / or Baseline Fields in the Production Schedule.

### Target S Curves

- These S Curves are generated from the Production Schedule, assuming all Tasks are completed as scheduled.

### Actual S Curves

- These S Curves are also generated from the Production Schedule, using Task % Complete values to date. Actual S Curves may also be referred to as Progress or Progress To Date S Curves.

## 3.1 S Curve Quantities

Each of the above S Curves may include one of the following quantities on the Quantity (Y) axis:

- Man Hours
- Cost

## 3.2 S Curve Quantity Units

Each of the above S Curves may use one of the following units for the values on the Quantity (Y) axis:

- Absolute Values for Man Hours and / or Cost
- Percentage Values for Man Hours and / or Cost

### 3.3 Baseline S Curves

Prior to Project commencement, a schedule is prepared outlining the proposed allocation of resources and the timing of Tasks necessary to complete the Project within a set time frame and budget. This schedule is referred to as the Baseline Schedule.

Once all the Tasks and their associated planned dates and values have been entered, the schedule should be baselined. In MS Project, baselining a project will copy the Task dates and values to the appropriate Baseline Fields. When the Baseline Schedule is copied to create the Production Schedule, these Baseline values will be available in the Production Schedule. This allows for the generation of Baseline S Curves from the Production Schedule.

The Baseline Schedule may be used to generate Baseline S Curves. These S Curves reflect the planned progress of the Project. If the Project requirements change prior to commencement (e.g. change of scope, delayed start, etc.), the Baseline Schedule may require revision and re-baselining to reflect the changed requirements.

Once the Project has commenced, the original Baseline Schedule should be left unchanged. Although it may be tempting to re-baseline the Baseline Schedule to cover changes in scope, delays, variations, etc. this should not be done. The Baseline Schedule is a fixed snapshot of the Project's original timeframe and budget. Any changes that occur during the Project's lifetime will be readily visible when the Production Schedule is compared to the Baseline Schedule. As such claims for variations, Extensions of Time, Excusable Delays, etc. may be raised as required, using the Baseline Schedule as evidence of the original Project's scope and timing.

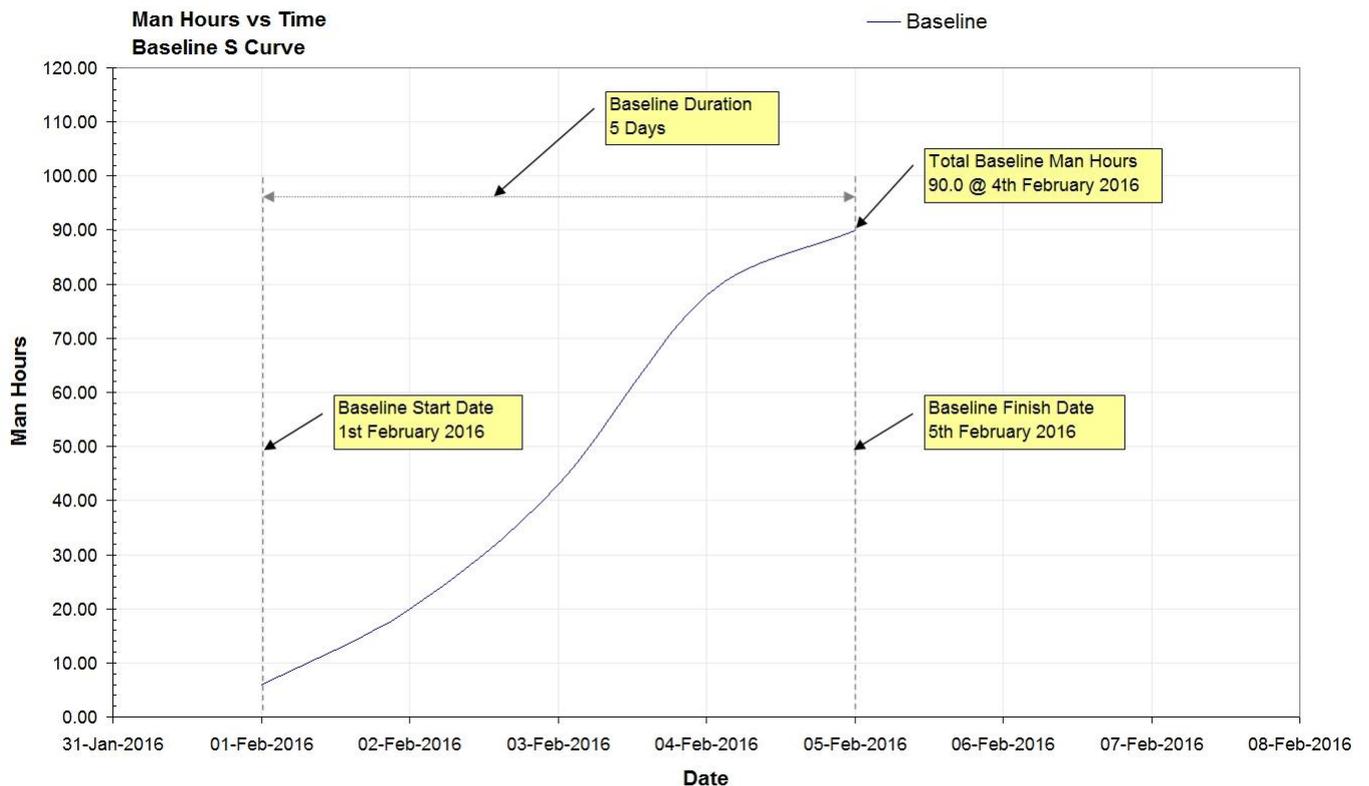


Figure 1: Baseline S Curve

### 3.4 Target S Curves

Following Project commencement, the Project’s schedule will usually require changes. As the Baseline Schedule should not be changed once the Project has commenced, these changes are instead made to the Production Schedule. The Production Schedule is created by making a copy of the Baseline Schedule. If the Baseline Schedule was baselined, the Production Schedule will include Baseline dates and values for the original Tasks as well as their planned production dates and values.

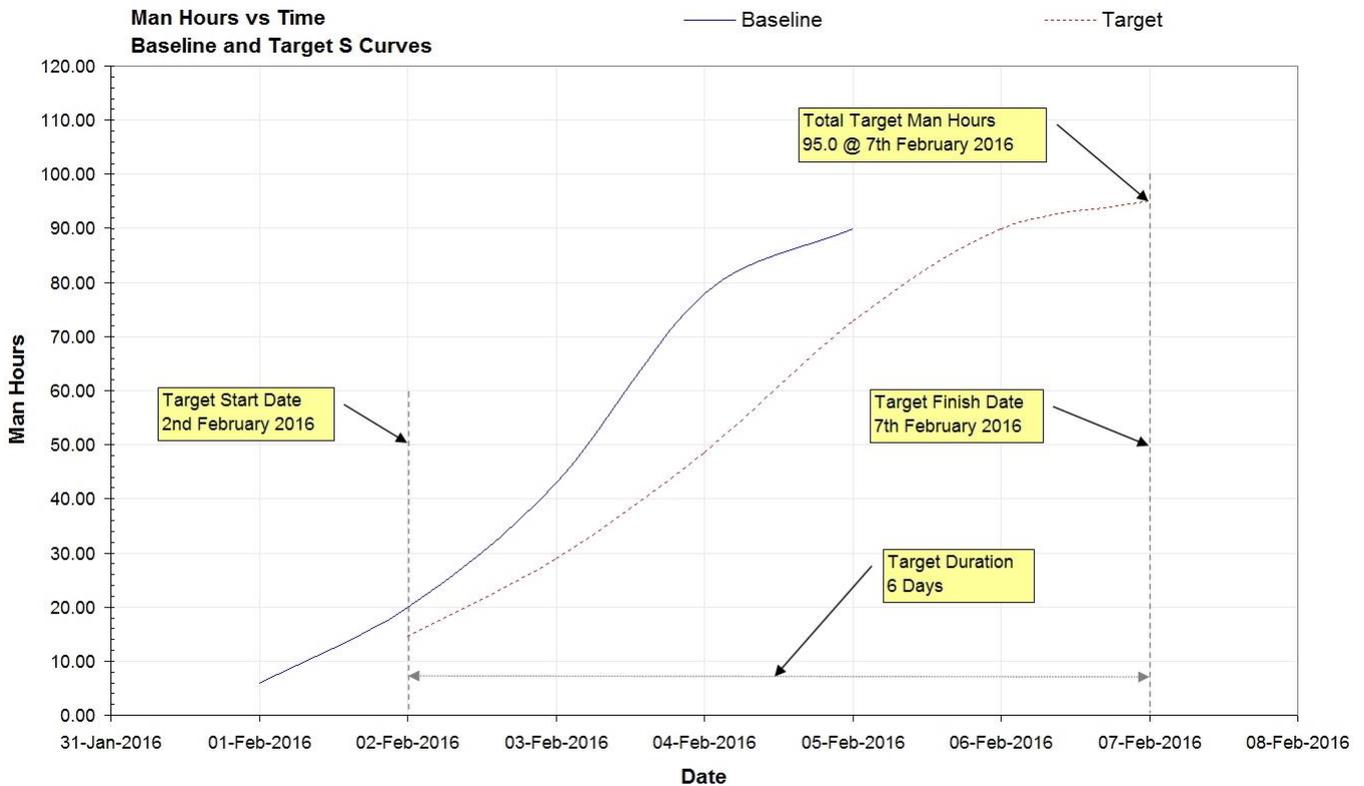
The Production Schedule reflects the actual progress of the Project to date (Task % Complete to date), any Tasks added to and / or removed from the Project, any revisions made to Tasks yet to commence or not yet finished, as well as actual dates and values for Tasks that are ongoing or have finished.

Tasks that do not contain valid Start Dates and / or Finish Dates, and / or zero quantities for Man Hours and / or Cost cannot be used to generate S Curves. So it is important to note that the Production Schedule must contain valid dates and values for all Tasks, regardless of whether the Task has commenced or not.

Originally these Task dates and values will be the same as the Baseline Schedule (provided the Baseline Schedule was baselined, and copied to create the Production Schedule). Task dates and values may be amended as required using actual values (such as when the Task actually started, finished, Man Hours / Cost actually expended, etc.) or estimated dates and values for Tasks that are yet to commence or have not yet finished.

The Production Schedule may be used to generate Target S Curves, as well as the original Baseline S Curves if it contains Baseline data. The Target S Curves reflect the progress of the Project if all Tasks are completed as currently scheduled.

In an ideal world, the Target S Curves will meet the Baseline S Curves at the completion of the Project (On Time, On Budget) or finish below and to the left of the Baseline S Curves (Finished Early, Under Budget). In reality, it is not uncommon for the Target S Curves to finish above and to the right of the Baseline S Curves (Finished Late, Over Budget). The Target S Curves will usually change over the duration of the Project due to changes to Task Start Dates and Finish Dates, Man Hours, and / or Cost.



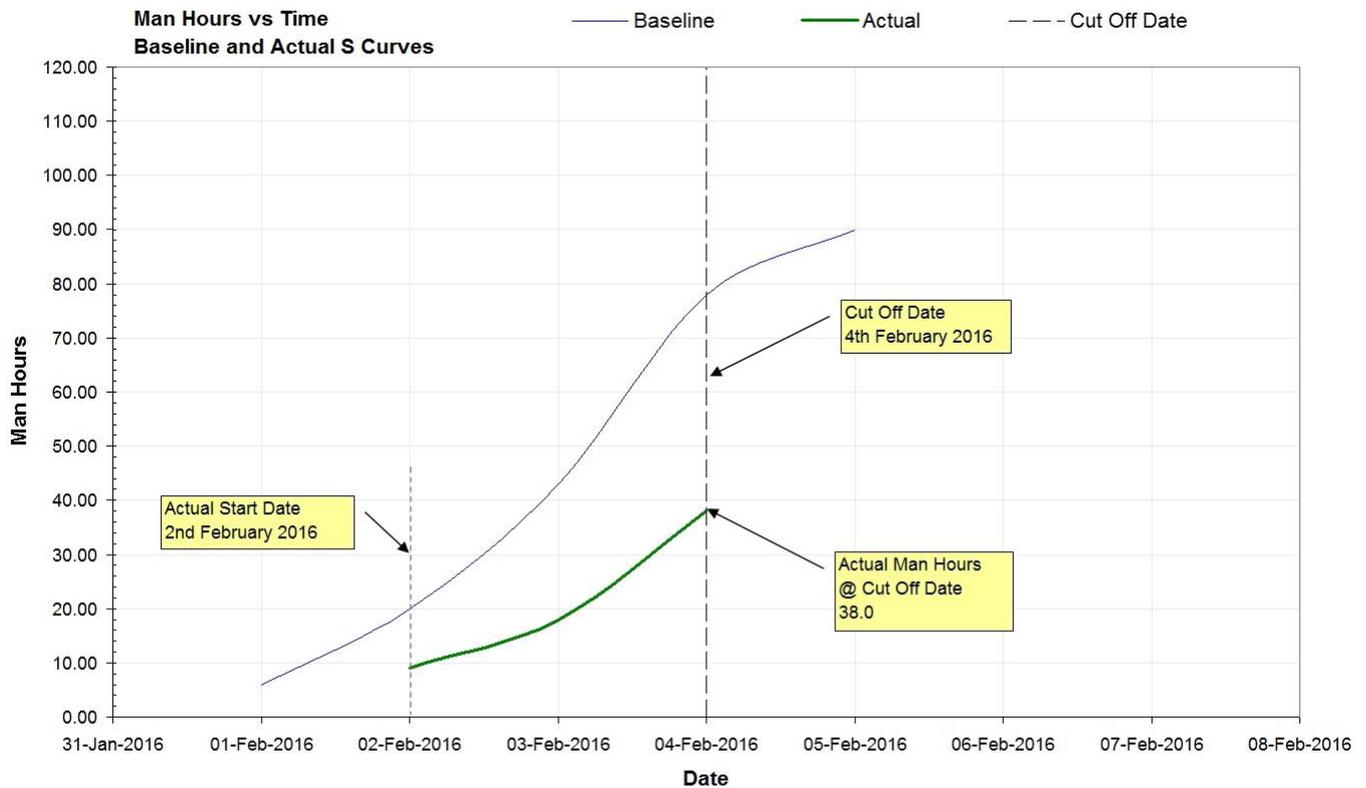
**Figure 2: Target S Curve (Showing Baseline S Curve For Comparison)**

### 3.5 Actual S Curves

The Production Schedule is updated on a regular basis throughout the duration of the Project. These updates include revising of the Task Start Dates and Finish Dates, and updating of Task % Complete values.

Using this information, Actual S Curves may be generated. These S Curves reflects the actual progress of the Project to date, and may be compared with the Baseline and Target S Curves to determine how the project is progressing as compared to the original Baseline Schedule.

During the Project, Actual S Curves will terminate at the Cut Off Date.



**Figure 3: Actual S Curve (Showing Baseline S Curve For Comparison)**

#### 3.5.1 What Is The Cut Off Date?

The Cut Off Date is the date on which all Tasks were physically inspected to determine their % Complete values. For example, if all Tasks were inspected on Thursday the 4th of February 2016, the Production Schedule was updated on Friday the 5th of February 2016, and the Actual S Curves were generated on Saturday the 6th of February 2016, the Cut Off Date should be set to Thursday the 4th of February 2016.

At the completion of the Project, with all Tasks 100% complete, the Actual S Curves will terminate at the Project Completion Date, and be identical to the Target S Curves. The Actual S Curves will usually change shape over the duration of the Project due to changes to Task Start Dates and Finish Dates, Man Hours and / or Cost, and Task % Complete to date.

### 3.5.2 Changing the Cut Off Date After The Production Schedule Has Been Updated

If the Actual S Curve is to be accurate, the Cut Off Date must be set to the date all the Project's Tasks were physically inspected for Task % Complete.

As shown below, the Project's Tasks were physically inspected on the 4th of February 2016. This is the Cut Off Date that should be used when generating Actual S Curves.

Using an earlier or later Cut Off Date can dramatically alter the shape of the Actual S Curve, as shown below. Generally, using an earlier Cut Off Date will push the Actual S Curves higher, while using a later Cut Off Date will push the Actual S Curves lower.

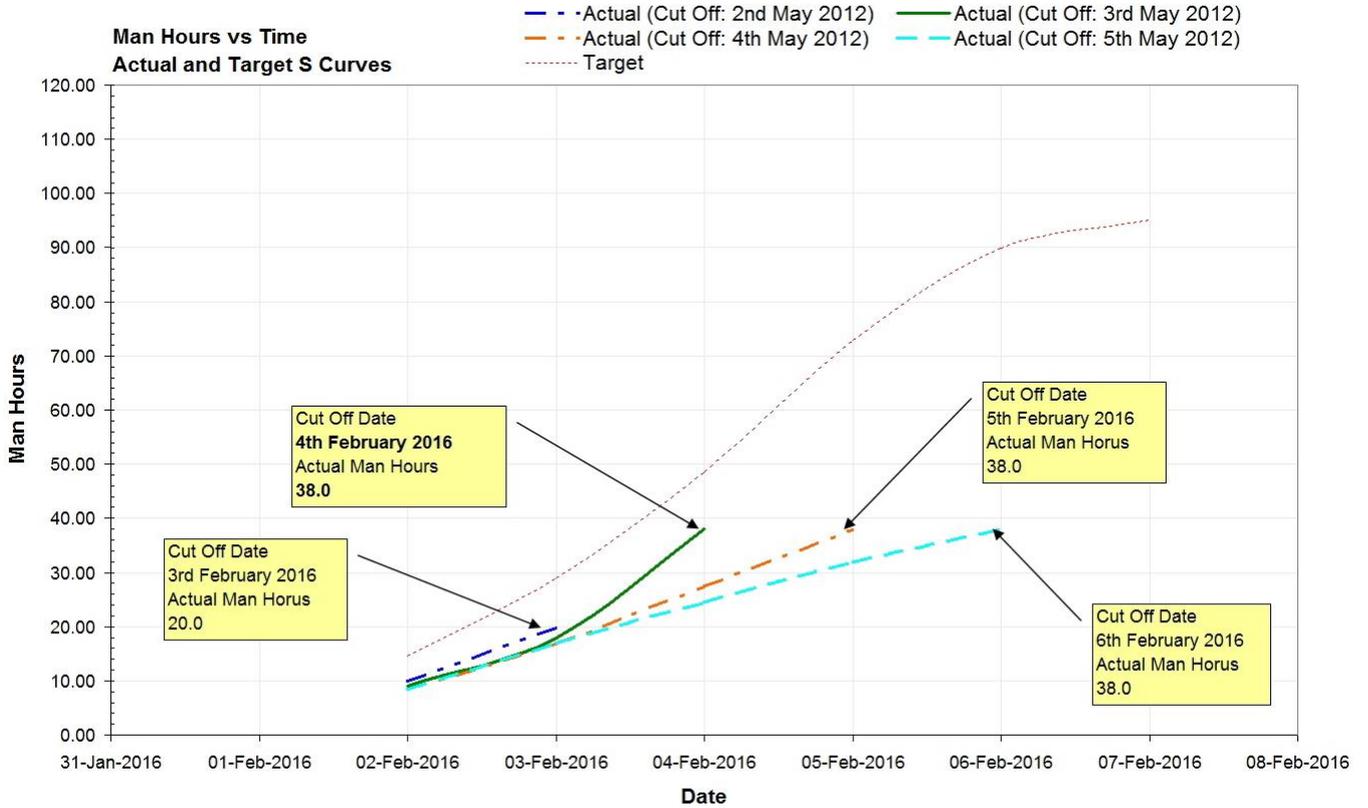


Figure 4: Example of Actual S Curves Using Different Cut Off Dates

### 3.6 Man Hours versus Time S Curves

Man Hours versus Time S Curves are appropriate for Projects that are labour intensive. It shows cumulative Man Hours expended over time for the duration of the Project. As Man Hours are a product of Man Power and working hours, these may be adjusted together or individually in an attempt to keep the Project on track. Projects may require additional Man Hours to finish on time due to low productivity, weather or other delays and disruptions, rework, variations, change of scope, etc.

### 3.7 Cost versus Time S Curves

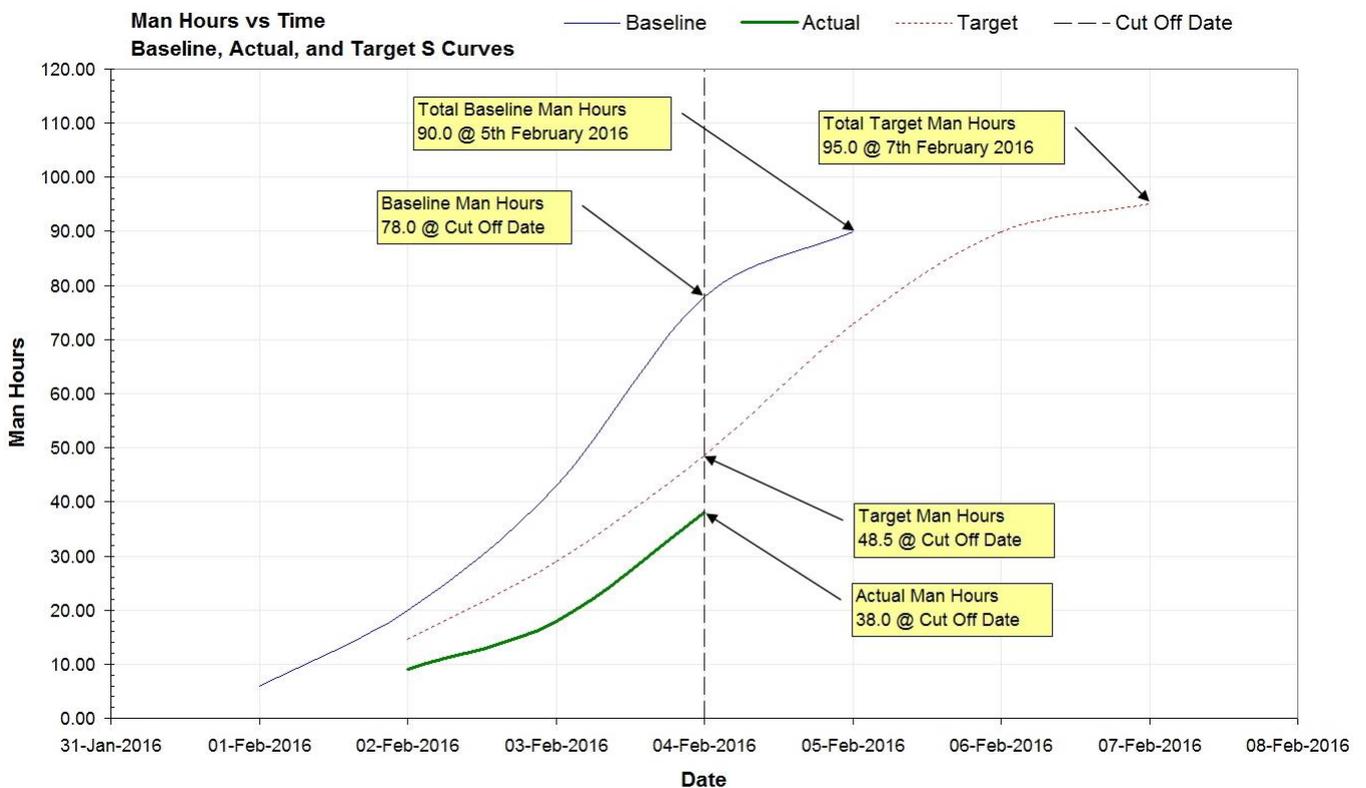
Cost versus Time S Curves are appropriate for Projects that contain labour and non-labour (e.g. material supply / hire / subcontract) Tasks. It shows cumulative Cost expended over time for the duration of the Project, and may be used to assist in the calculation of the Project's cash flow, and Cost To Complete.

### 3.8 Value and Percentage S Curves

S Curves may be graphed as absolute values (i.e. Man Hours or Cost) versus Time, or as percentage values versus Time.

#### 3.8.1 Value S Curves

Value S Curves are useful for determining the Project's Man Hours or Cost expended to date, and Man Hours or Cost to complete.



**Figure 5: Value Baseline, Actual, and Target Man Hours versus Time S Curves**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

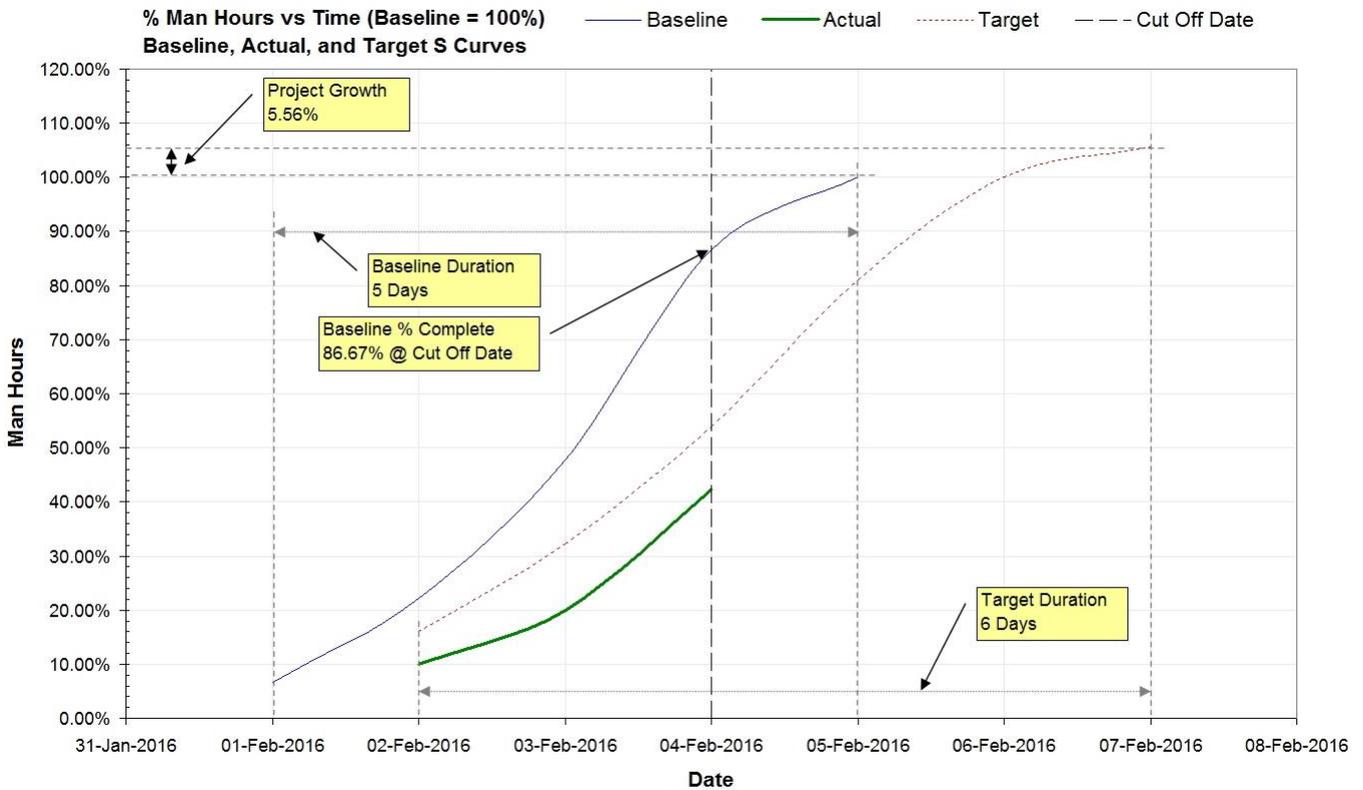
- Is 10.5 Man Hours behind schedule (48.5 – 38.0)
- Has grown in scope by 5.0 Man Hours (95.0 – 90.0)
- Has increased in Duration by 1 Day
- Started 1 Day late
- Will finish 2 Days late
- Will require 57.0 Man Hours to complete (95.0 – 38.0)

### 3.8.2 Percentage S Curves

Percentage S Curves are useful for comparing the Project's performance to either the Baseline and / or Production Schedule.

#### 3.8.2.1 Percentage S Curves (Baseline = 100%)

By setting the Baseline S Curve to finish at 100%, the Project's percentage growth (or contraction) may be compared to the Baseline Schedule, and the Baseline % Complete as of the Cut Off Date may be determined.



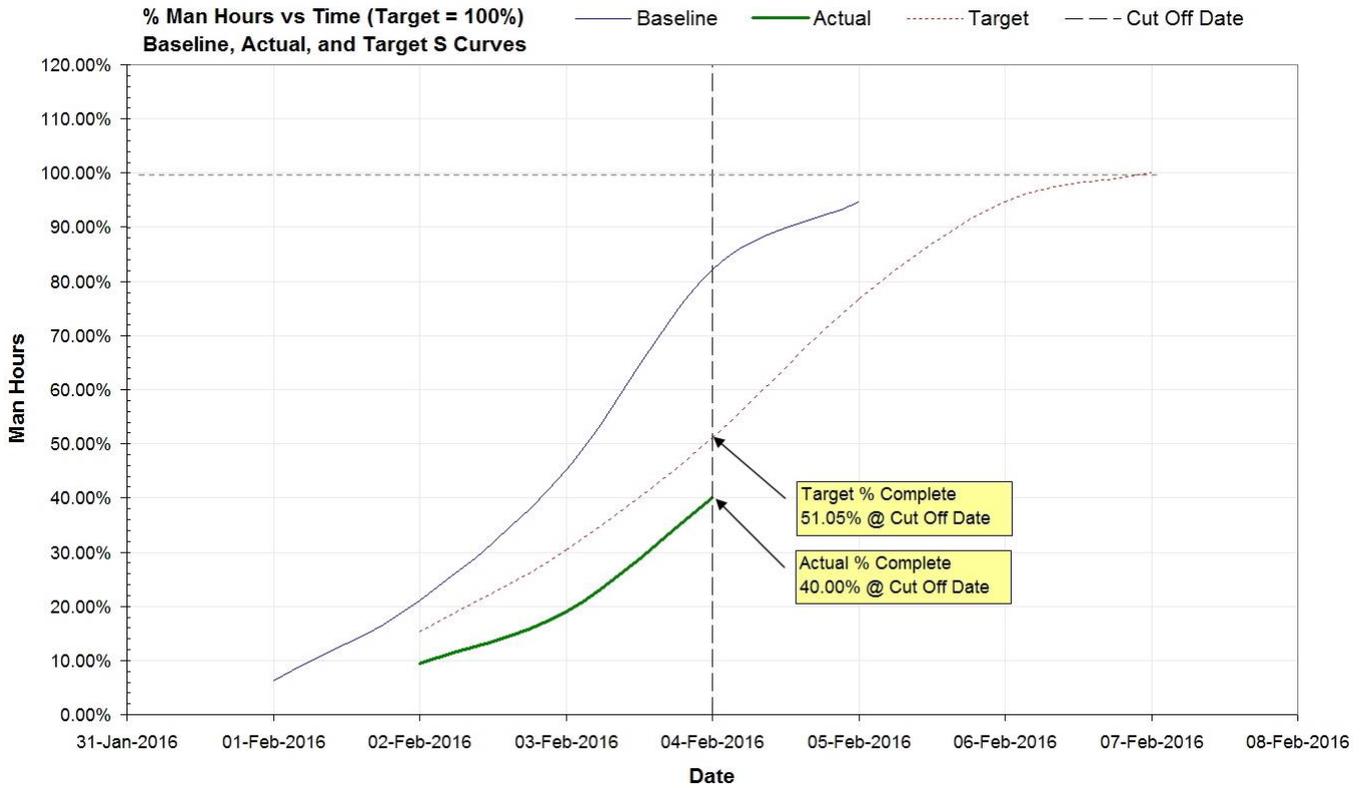
**Figure 6: Percentage Man Hours versus Time (Baseline = 100%) S Curves**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Has grown in scope by 5.56% (105.56 – 100.00)
- Was planned to be 86.67% complete

### 3.8.2.2 Percentage S Curves (Target = 100%)

By setting the Target S Curve to finish at 100%, the Project's Actual % Complete may be compared to the Target % Complete as of the Cut Off Date.



**Figure 7: Percentage Man Hours versus Time (Target = 100%) S Curves**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Is 11.05% behind target (51.05 – 40.00)

#### **4.0 How is an S Curve Generated?**

To generate a Baseline S Curve, a Baseline Schedule is required, or a Production Schedule containing the Baseline dates and values of the original Tasks.

The Baseline Schedule / Production Schedule should contain the following information for each Task...

- Baseline Start Date, Finish Date
- Baseline Man Hours and / or Cost

To generate Actual and Target S Curves, a Production Schedule is required.

The Production Schedule should contain the following information for each Task...

- Start Date, Finish Date (if actual dates are unknown, Baseline / estimated dates should be used)
- Man Hours and / or Cost (if actual values are unknown, Baseline / estimated values should be used)
- % Complete (as of the Cut Off Date)

If a Baseline S Curve is also to be generated with the Actual and / or Target S Curves, the Production Schedule should also contain Baseline dates and values for each original Task in the appropriate Baseline Fields. This is usually the case if the Baseline Schedule was baselined, and copied to create the original Production Schedule.

#### 4.1 Schedule Integrity

The accuracy of S Curves generated from the Baseline or Production Schedule is dependent on the integrity of the Baseline and / or Production Schedule.

If the Schedule contains Invalid Tasks (those with undefined Start and / or Finish Dates), or Tasks with inaccurate values (zero values for Man Hours and / or Cost, inaccurate Start and / or Finish Dates and % Complete values with respect to the Cut Off Date), the resulting S Curves will be inaccurate.

Invalid Tasks must be ignored when generating S Curves, while Tasks with inaccurate values will impact on the accuracy of any S Curves generated.

##### 4.1.1 Invalid Tasks

Every Task must contain valid Start Dates and Finish Dates (baseline, actual, or estimated dates) so that the Task's Duration may be calculated.

The Tasks shown below are all invalid (as the Task Duration cannot be calculated), and as such these Tasks must be ignored when generating S Curves.

Task Name	Start Date	Finish Date	Man Hours	Cost	% Complete	Reason Task Is Invalid
Task No. 1	N/A	N/A	10.0	100.00	0%	Invalid Start Date, Finish Date. Unable to calculate Task Duration.
Task No. 2	N/A	04-Feb-2016	10.0	100.00	0%	Invalid Start Date. Unable to calculate Task Duration.
Task No. 3	01-Feb-2016	N/A	10.0	100.00	0%	Invalid Finish Date. Unable to calculate Task Duration.

**Table 1: Examples of Invalid Tasks**

The following changes are required to correct the invalid Tasks shown above.

**Task No. 1:** Valid Start Dates and Finish Dates are required.  
If actual Start Dates and Finish Dates are unknown, baseline or estimated dates should be used.

**Task No. 2:** A valid Start Date is required.  
If the actual Start Date is unknown, the Baseline Start Date or an estimated Start Date should be used.

**Task No. 3:** A valid Finish Date is required.  
If the actual Finish Date is unknown, the Baseline Finish Date or an estimated Finish Date should be used.

### 4.1.2 Task Warnings

Each Task (other than Milestone Tasks) must contain a non-zero value for Man Hours and / or Cost, as Tasks with zero values for these quantities have no bearing on S Curves. Negative values for Man Hours and / or Cost may be assigned if required (this usually occurs with Variation Tasks that de-scope existing Tasks).

Tasks that have not yet commenced as of the Cut Off Date cannot have a non-zero % Complete value, and Tasks that have finished as of the Cut Off Date must be 100% Complete.

Tasks with inaccurate Start Dates, Finish Dates, and / or % Complete values should be corrected as required to ensure accurate S Curves are generated.

Task Name	Start Date	Finish Date	Man Hours	Cost	% Complete	Task Warning
Task No. 4	01-Feb-2016	04-Feb-2016	0.0	100.00	0%	Zero Man Hours. Does not affect Man Hours S Curves.
Task No. 5	01-Feb-2016	04-Feb-2016	10.0	0.00	0%	Zero Cost. Does not affect Cost S Curves.
Task No. 6	01-Feb-2016	02-Feb-2016	10.0	100.00	90%	Task has finished, but is only 90% complete.
Task No. 7	05-Feb-2016	08-Feb-2016	10.0	100.00	5%	Task has not started, but is 5% complete.

**Cut Off Date** | 4th Feb 2016

**Table 2: Examples of Task Warnings**

The following changes are required to correct the Tasks shown above.

- Task No. 4:** A non-zero quantity for Man Hours should be used.  
If actual Man Hours are unknown, baseline or estimated Man Hours should be used.
- Task No. 5:** A non-zero quantity for Cost should be used.  
If the actual Cost is unknown, baseline or estimated Cost should be used.
- Task No. 6:** If the Task has finished, the % Complete value should be set to 100%.  
If the Task is still in progress, the Finish Date should be moved right beyond the Cut Off Date, and the % Complete value adjusted if required.
- Task No. 7:** If the Task has not started, the % Complete value should be set to 0%.  
If the Task has started, the Start Date should be moved left to or before the Cut Off Date, and the % Complete value adjusted if required.

**4.1.3 Start Dates, Finish Dates, % Complete, And The Cut Off Date**

When generating Actual S Curves, it is important to ensure Tasks contain valid baseline / estimated / actual Start Dates and Finish Dates along with accurate % Complete values. When updating a Production Schedule containing numerous Tasks, it is easy to overlook Tasks that contain invalid dates and / or % Complete values.

Three of the most common issues found are:

- Tasks scheduled to finish prior to the Cut Off Date yet are not 100% complete
- Tasks scheduled to finish prior to the Cut Off Date yet are 0% complete
- Tasks scheduled to start after the Cut Off Date yet are not 0% complete

Consider the following example Tasks, with the Cut Off Date set to 4th February 2016.

Task	Start	Finish	% Complete	February, 2016							
				1	2	3	4	5	6	7	
Task No. 1	01-Feb-2016	02-Feb-2016	50%	█	█						
Task No. 1A	01-Feb-2016	02-Feb-2016	100%	█	█						
Task No. 1B	01-Feb-2016	05-Feb-2016	50%	█	█	█	█				
Task No. 2	01-Feb-2016	02-Feb-2016	0%								
Task No. 2A	01-Feb-2016	05-Feb-2016	20%	█							
Task No. 2B	05-Feb-2016	07-Feb-2016	0%								
Task No. 3	05-Feb-2016	06-Feb-2016	25%						█		
Task No. 3A	05-Jun-2016	06-Feb-2016	0%								
Task No. 3B	03-Feb-2016	06-Feb-2016	25%			█					

**Figure 8: Examples of Tasks with Invalid Start Dates, Finish Dates, and / or % Complete Values**

**4.1.3.1 Tasks Scheduled To Finish Prior To The Cut Off Date Yet Are Not 100% Complete**

Task No. 1 is an example of a Task that should have finished before the Cut Off Date (indicated by the dashed red line), but is not 100% finished.

Such Tasks either need to have their % Complete value set to 100% if they are finished (refer Task No. 1A), or have their Finish Date pushed right beyond the Cut Off Date if they are not finished (refer Task No. 1B).

**4.1.3.2 Tasks Scheduled To Finish Prior To The Cut Off Date Yet Are 0% Complete**

Task No. 2 is an example of a Task that should have finished before the Cut Off Date (indicated by the dashed red line), but has not started.

Such Tasks either need to have their % Complete value changed from 0% if they have started (refer Task No. 2A), or have their Start Date pushed right beyond the Cut Off Date if they have not yet started (refer Task No. 2B).

**4.1.3.3 Tasks Scheduled To Start After The Cut Off Date Yet Are 0% Complete**

Task No.3 is an example of a Task that is scheduled to start after the Cut Off Date (indicated by the dashed red line), but has a non-zero % Complete value assigned.

Such Tasks either need to have their % Complete value set to 0% if they have not started (refer Task No. 3A), or have their Start Date moved left to or before the Cut Off Date if the Task has already started (refer Task No. 3B).

### 4.2 Summary and Detail Tasks

It is common for both the Baseline and Production Schedules to contain a combination of Summary and Detail Tasks. It is important to note that only Detail Tasks should be considered when generating S Curves. Summary Tasks must be ignored. For example, a Project has one Summary Task, four Details Tasks, and a total of 90 Man Hours. If the Summary Task is included in the Baseline S Curve calculations, the total Man Hours are doubled, as the Summary Task contains the total Man Hours of the four Detail Tasks.

Compare Table 3, below which includes the Summary and Details Task in the Baseline S Curve calculations with Tables 4 and 5, which only include the Detail Tasks.

Task Name	Baseline Start	Baseline Finish	Baseline Man Hours	Baseline <sup>(1)</sup> Duration	Baseline <sup>(2)</sup> MH per Day
<b>Project Summary</b>	<b>01-Feb-2016</b>	<b>05-Feb-2016</b>	<b>90.0</b>	<b>5</b>	<b>18</b>
Task No. 1	01-Feb-2016	02-Feb-2016	12.0	2	6
Task No. 2	02-Feb-2016	04-Feb-2016	24.0	3	8
Task No. 3	03-Feb-2016	04-Feb-2016	30.0	2	15
Task No. 4	04-Feb-2016	05-Feb-2016	24.0	2	12
<b>Totals</b>			<b>180.0</b>		

Task / Date	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016
<b>Project Summary</b>	<b>18.0</b>	<b>18.0</b>	<b>18.0</b>	<b>18.0</b>	<b>18.0</b>
Task No. 1	6.0	6.0	-	-	-
Task No. 2	-	8.0	8.0	8.0	-
Task No. 3	-	-	15.0	15.0	-
Task No. 4	-	-	-	12.0	12.0
<b>Totals per Day <sup>(3)</sup></b>	24.0	32.0	41.0	53.0	30.0
<b>YTD Totals <sup>(4)</sup></b>	24.0	56.0	97.0	150.0	<b>180.0</b>

**Table 3: Baseline S Curve Calculations, Including Summary Task**

### 4.3 Milestone Tasks

As Milestone Tasks have zero Duration, they are not included when generating S Curves.

### 4.4 Worked Example

To better understand how S Curves are generated, consider a simple Project consisting of five Tasks. The first Task is a Summary Task, and thus must be ignored. The remaining four Tasks are Detail Tasks. Please note that although this worked example will only consider Man Hours, the calculations shown below are identical if Cost is used in lieu of Man Hours.

A Baseline Schedule prepared using MS Project for the example project is shown below.



**Figure 9: Sample Baseline Schedule**

4.4.1 Baseline Man Hours versus Time S Curve

To generate a Baseline Man Hours versus Time S Curve, two sets of calculations are required.

The first set of calculations are performed for each Task in the Baseline Schedule.

- (1) Calculate the Duration in Days for each Task

$$\text{Baseline Duration} = \text{Baseline Finish Date} - \text{Baseline Start Date} + 1$$

- (2) Calculate Man Hours per Day for each Task

$$\text{Baseline Man Hours per Day} = \text{Baseline Man Hours} / \text{Baseline Duration}$$

These calculations are shown below.

Task Name	Baseline Start	Baseline Finish	Baseline Man Hours	Baseline <sup>(1)</sup> Duration	Baseline <sup>(2)</sup> MH per Day
Task No. 1	01-Feb-2016	02-Feb-2016	12.0	2	6
Task No. 2	02-Feb-2016	04-Feb-2016	24.0	3	8
Task No. 3	03-Feb-2016	04-Feb-2016	30.0	2	15
Task No. 4	04-Feb-2016	05-Feb-2016	24.0	2	12
<b>Totals</b>			<b>90.0</b>		

Table 4: Baseline S Curve Calculation 1 of 2

The second set of calculations are performed for each Day in the Baseline Schedule.

- (3) Calculate the total Man Hours per Day for all Tasks
- (4) Calculate the Year To Date Total for Man Hours per Day for all Tasks

These calculations are shown below.

Task / Date	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016
Task No. 1	6.0	6.0	-	-	-
Task No. 2	-	8.0	8.0	8.0	-
Task No. 3	-	-	15.0	15.0	-
Task No. 4	-	-	-	12.0	12.0
<b>Totals per Day <sup>(3)</sup></b>	6.0	14.0	23.0	35.0	12.0
<b>YTD Totals <sup>(4)</sup></b>	6.0	20.0	43.0	78.0	<b>90.0</b>

Table 5: Baseline S Curve Calculation 2 of 2

4.4.1 Baseline Man Hours versus Time S Curve (Continued)

The Baseline S Curve is constructed by assigning the Baseline dates to the X Axis, and the Year To Date (YTD) values to the Y Axis. The resulting Baseline Man Hours versus Time S Curve is shown below.

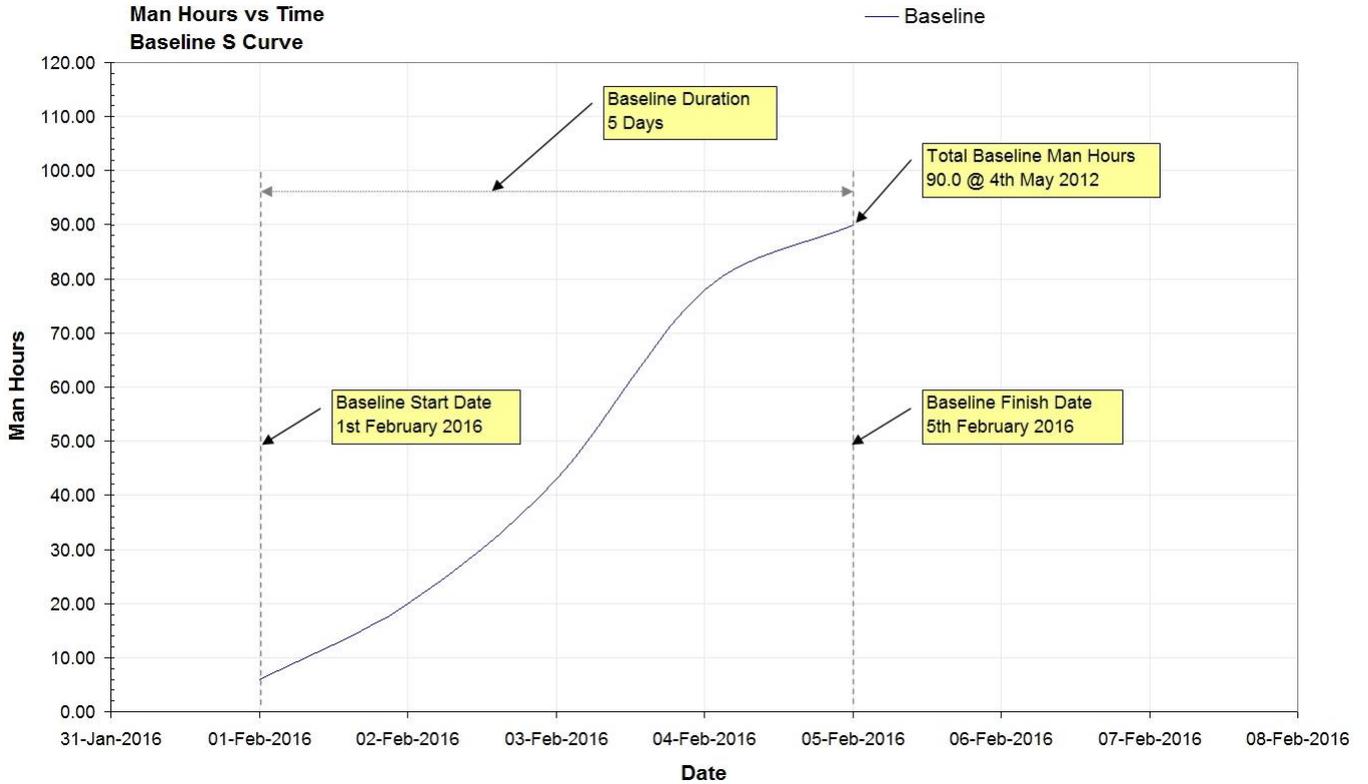


Figure 10: Baseline Man Hours versus Time S Curve

Please note that the Totals per Day values may be used to generate a Baseline Man Hours Histogram by assigning the dates to the X Axis, and the Totals per Day values to the Y Axis, as shown below.

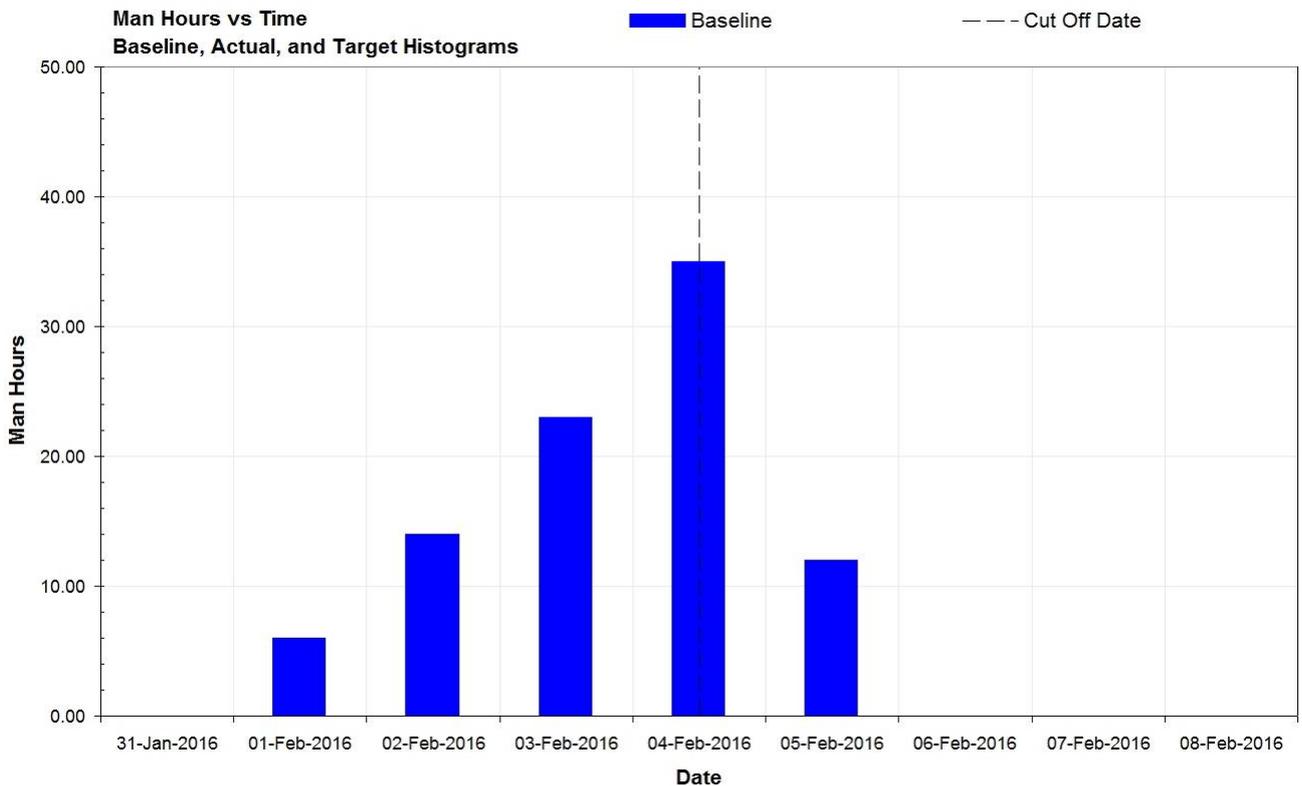


Figure 11: Baseline Man Hours versus Time Histogram

#### 4.4.2 Target Man Hours versus Time S Curve

To generate the Actual and Target S Curves, a Production Schedule is required. For the purpose of this example, the Production Schedule will contain the same five Tasks (one Summary Task, four Detail Tasks) as the Baseline Schedule. Once again, the Summary Task must be ignored to ensure the calculations are accurate.

A Production Schedule for the example Project is shown below.



Figure 12: Sample Production Schedule

Note this schedule contains the Baseline data from the Production Schedule. This allows Baseline S Curves to be generated from the Production Schedule.

To generate a Target Man Hours versus Time S Curve, two sets of calculations are performed.

The first set of calculations are performed for each Task in the Production Schedule.

- (1) Calculate the Duration in Days for each Task

$$Duration = Finish Date - Start Date + 1$$

- (2) Calculate Man Hours per Day for each Task

$$Man\ Hours\ per\ Day = Man\ Hours / Duration$$

These calculations are shown below.

Task Name	Start	Finish	Man Hours	% Complete	Duration <sup>(1)</sup>	MH per Day <sup>(2)</sup>
Task No. 1	02-Feb-2016	03-Feb-2016	14.0	100%	2	7.0
Task No. 2	02-Feb-2016	05-Feb-2016	30.0	20%	4	7.5
Task No. 3	04-Feb-2016	06-Feb-2016	36.0	50%	3	12.0
Task No. 4	05-Feb-2016	07-Feb-2016	15.0	0%	3	5.0
<b>Totals</b>			<b>95.0</b>			

Table 6: Target S Curve Calculation 1 of 2

4.4.2 Target Man Hours versus Time S Curve (Continued)

The second set of calculations are performed for each Day in the Production Schedule.

- (3) Calculate the total Man Hours per Day for all Tasks
- (4) Calculate the Year To Date Total for Man Hours per Day for all Tasks

These calculations are shown below.

Task / Date	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016	06-Feb-2016
Task No. 1	7.0	7.0	-	-	-	-
Task No. 2	7.5	7.5	7.5	7.5	-	-
Task No. 3	-	-	12.0	12.0	12.0	-
Task No. 4	-	-	-	5.0	5.0	5.0
<b>Totals per Day <sup>(3)</sup></b>	14.5	14.5	19.5	24.5	17.0	5.0
<b>YTD Totals <sup>(4)</sup></b>	14.5	29.0	48.5	73.0	90.0	<b>95.0</b>

Table 7: Target S Curve Calculation 2 of 2

The Target S Curve is constructed by assigning the dates to the X Axis, and the Year To Date (YTD) values to the Y Axis. The resulting Target Man Hours versus Time S Curve is shown below.

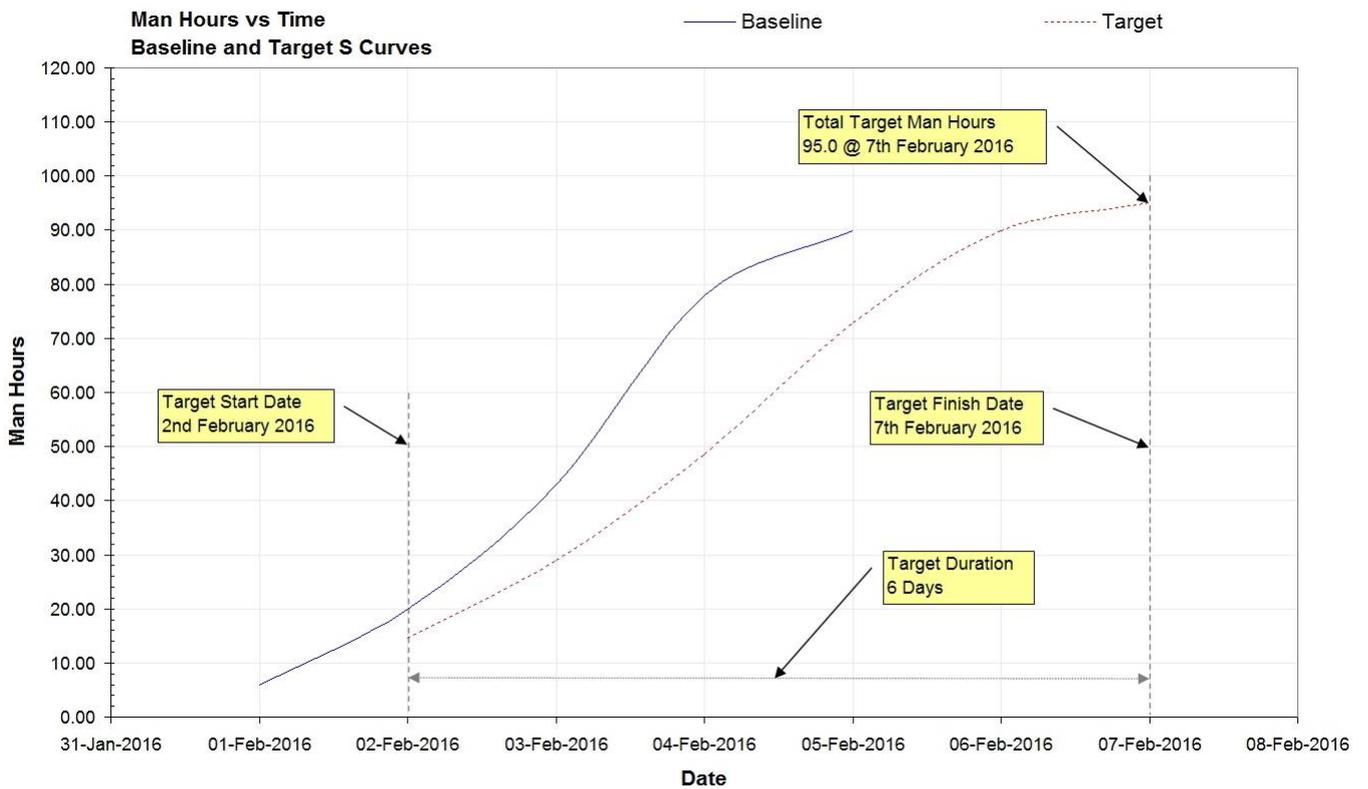


Figure 13: Target Man Hours versus Time S Curve (Showing Baseline S Curve For Comparison)

### 4.4.2 Target Man Hours versus Time S Curve (Continued)

Please note that the Totals per Day values may be used to generate a Target Man Hours Histogram by assigning the dates to the X Axis, and the Totals per Day values to the Y Axis, as shown below.

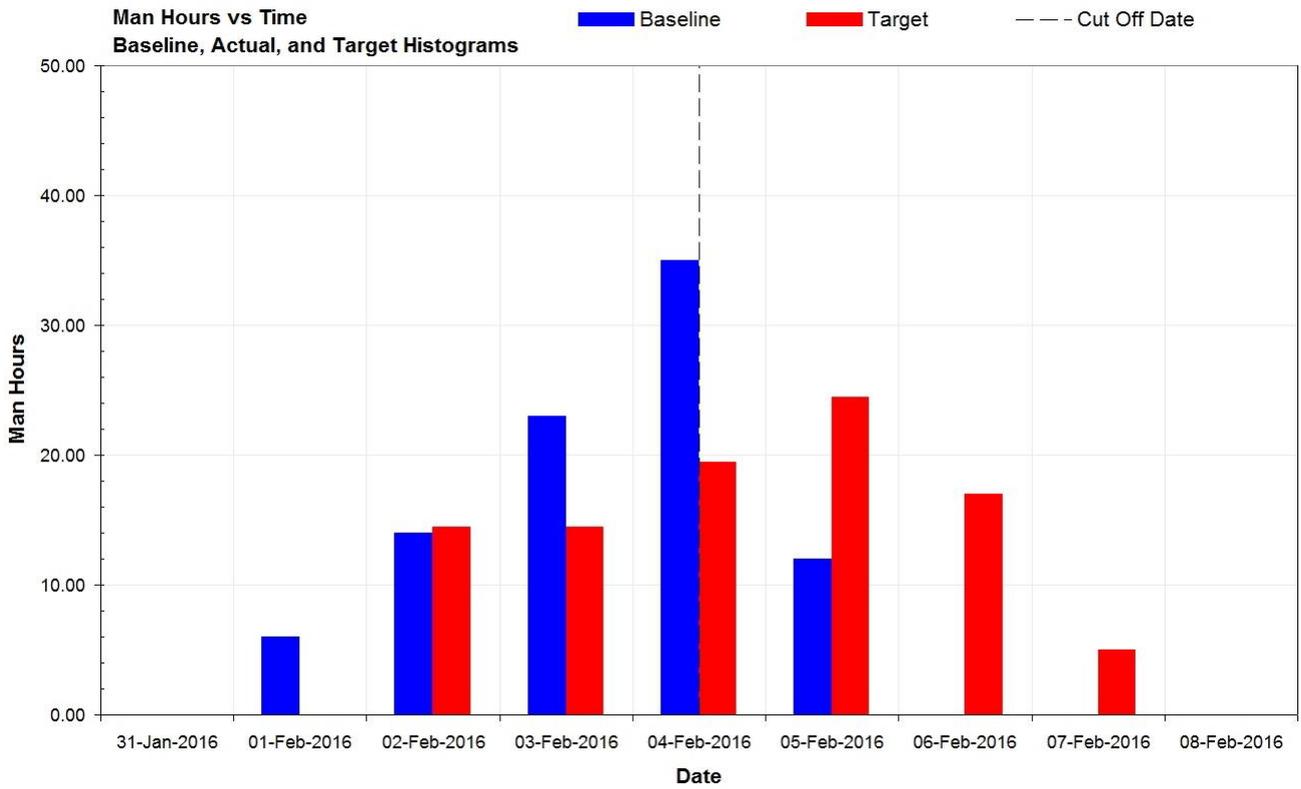


Figure 14: Target Man Hours versus Time Histogram (Showing Baseline Histogram For Comparison)

#### 4.4.3 Actual Man Hours versus Time S Curve

To generate an Actual Man Hours versus Time S Curve, two sets of calculations are performed. Before these calculations may be performed, the Cut Off Date needs to be defined. This is the date the Project's Tasks were last physically inspected to determine their % complete status. For this example a Cut Off Date of the 4th of February, 2016 will be used.

The first set of calculations are performed for each Task in the Production Schedule.

(1) Determine the Task Status: **Finished, In Progress, Not Started**.

- **Finished:** Tasks that have a Finish Date prior to the Cut Off Date.
- **In Progress:** Tasks that have started and have a Finish Date on or after the Cut Off Date.
- **Not Started:** Tasks that have a Start Date after the Cut Off Date.

(2) Calculate the Duration to Date based on the Task Status.

- **Finished:**  $Duration\ To\ Date = Finish\ Date - Start\ Date + 1$
- **In Progress:**  $Duration\ To\ Date = Cut\ Off\ Date - Start\ Date + 1$
- **Not Started:**  $Duration\ To\ Date = 0$

(3) Calculate Man Hours to Date for Finished and Ongoing Tasks.

$$Man\ Hours\ to\ Date = (Man\ Hours\ x\ \% \ Complete) / Duration\ to\ Date$$

As discussed above in the Target S Curve calculations, the total Task Man Hours to complete the Task are required.

In this worked example, the Production Schedule contains total Task Man Hours.

The required calculations are shown below.

Task Name	Start	Finish	Man Hours	% Complete	Status <sup>(1)</sup>	Duration <sup>(2)</sup> To Date	$\frac{MH \times \% \ Complete}{Duration\ To\ Date}$ <sup>(3)</sup>
Task No. 1	02-Feb-2016	03-Feb-2016	14.0	100%	Finished	2	7.0
Task No. 2	02-Feb-2016	05-Feb-2016	30.0	20%	In Progress	3	2.0
Task No. 3	04-Feb-2016	06-Feb-2016	36.0	50%	In Progress	1	18.0
Task No. 4	05-Feb-2016	07-Feb-2016	15.0	0%	Not Started	0	0.0
<b>Totals</b>			<b>95.0</b>				

**Table 8: Actual S Curve Calculation 1 of 2**

4.4.3 Actual Man Hours versus Time S Curve (Continued)

The second set of calculations are performed for each Day in the Production Schedule up to the Cut Off Date.

- (4) Calculate the total Man Hours to Date per Day for all Tasks
- (5) Calculate the Year To Date Total for Man Hours to Date per Day for all Tasks

These calculations are shown below.

Task / Date	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016	06-Feb-2016	07-Feb-2016
Task No. 1	7.0	7.0	-	-	-	-
Task No. 2	2.0	2.0	2.0	-	-	-
Task No. 3	-	-	18.0	-	-	-
Task No. 4	-	-	-	-	-	-
<b>Totals per Day <sup>(4)</sup></b>	9.0	9.0	20.0	-	-	-
<b>YTD Totals <sup>(5)</sup></b>	9.0	18.0	38.0	-	-	-

Cut Off Date **04-Feb-2016**

Table 9: Actual S Curve Calculation 2 of 2

The resulting Actual Man Hours versus Time S Curve is shown below.

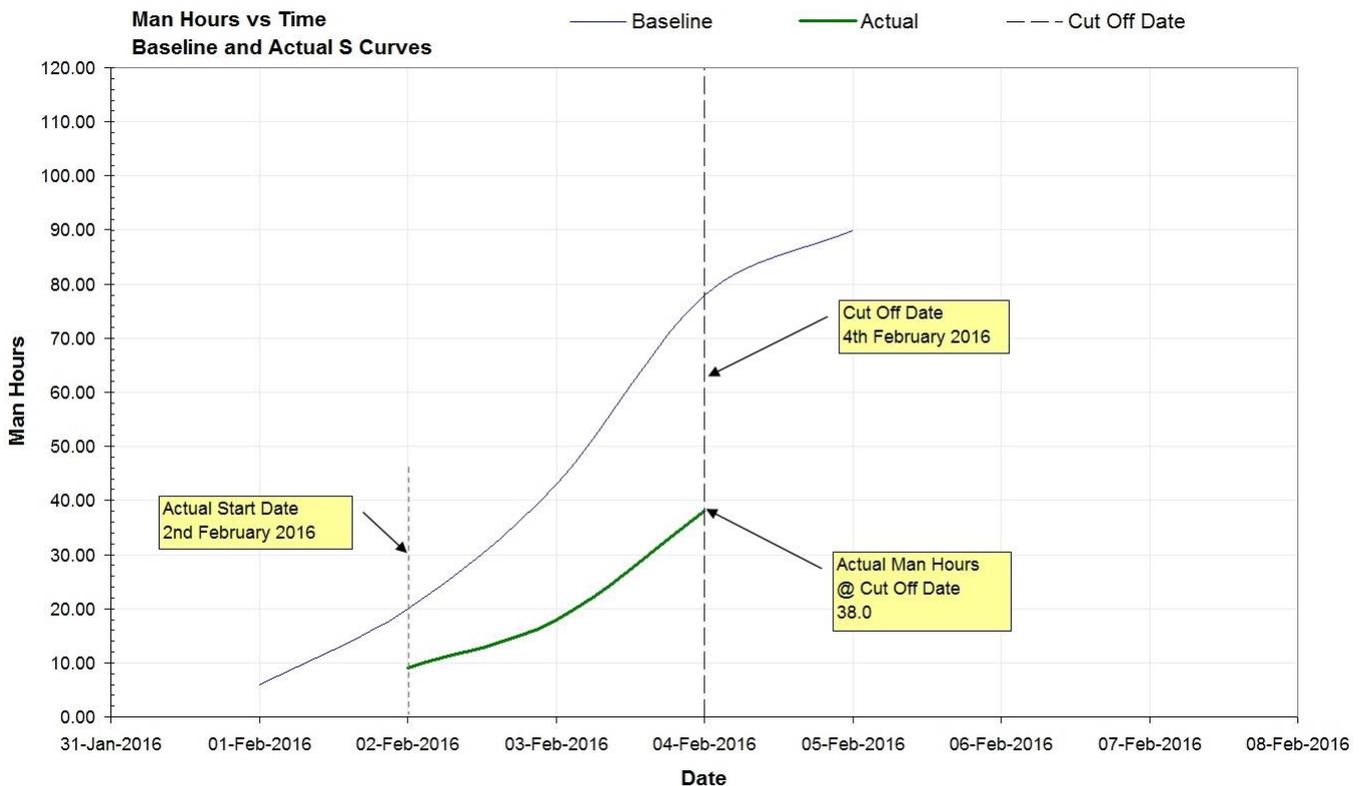


Figure 15: Actual Man Hours versus Time S Curve (Showing Baseline S Curve For Comparison)

4.4.3 Actual Man Hours versus Time S Curve (Continued)

Please note that the Totals per Day values may be used to generate an Actual Man Hours Histogram by assigning the dates to the X Axis, and the Totals per Day values to the Y Axis, as shown below.

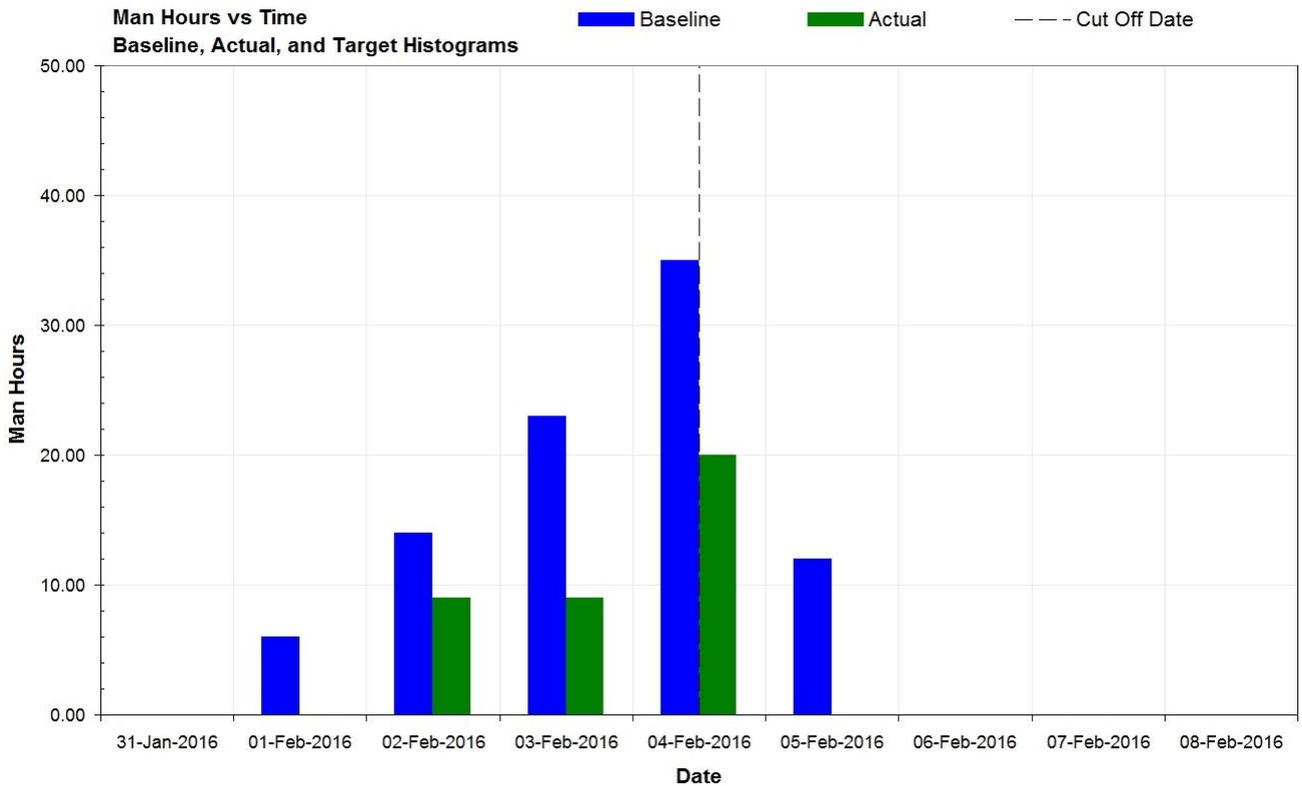


Figure 16: Actual Man Hours versus Time Histogram (Showing Baseline Histogram For Comparison)

The Baseline, Actual, and Target S Curves may be combined, as shown below.

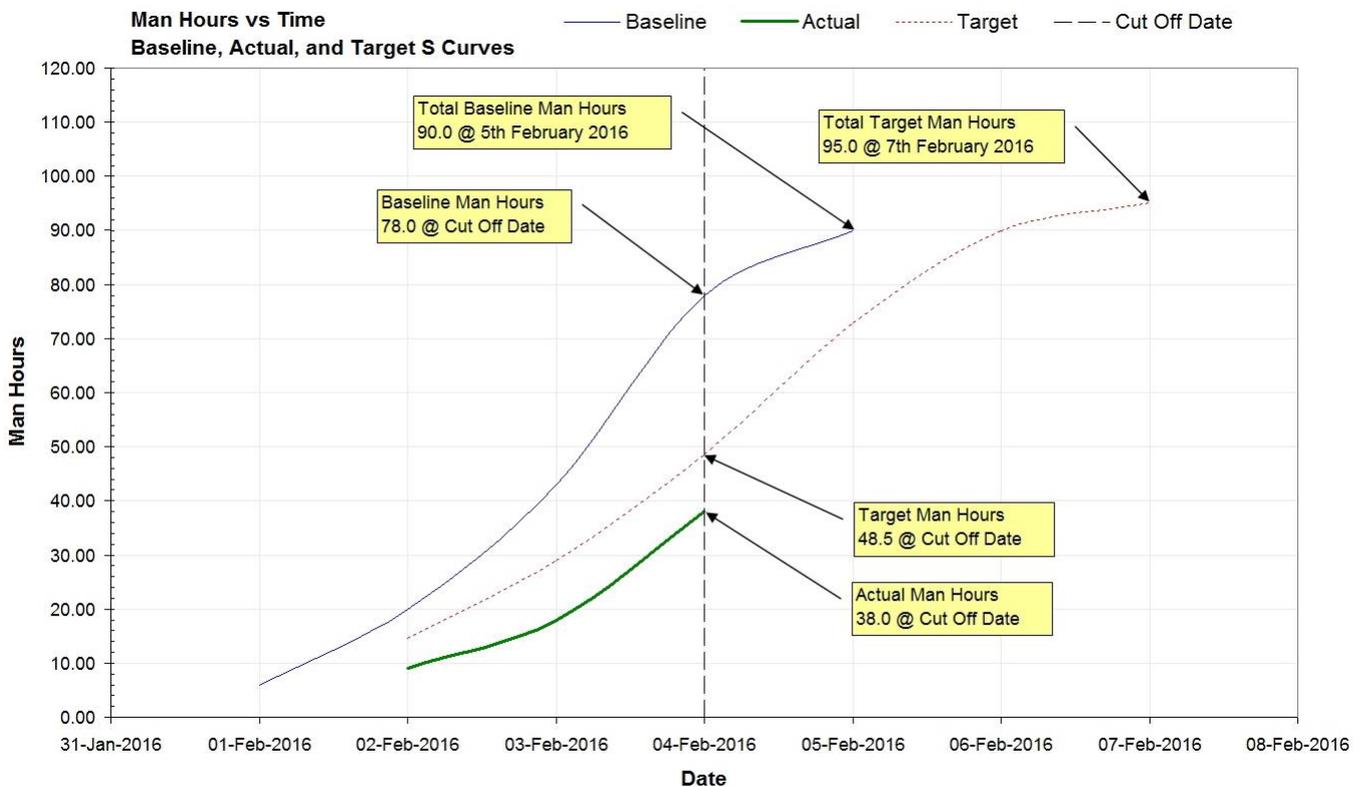


Figure 17: Man Hours versus Time S Curves

### 4.5 Generating Percentage S Curves

Percentage S Curves may be generated by dividing the Year To Date (YTD) daily totals for each Day for each S Curve (Baseline, Actual, Target) by either the total Baseline Man Hours (Baseline = 100%) or Target Man Hours (Target = 100%).

#### 4.5.1 Generating Percentage S Curves (Baseline = 100%)

To generate Percentage S Curves with the Baseline = 100%, divide the Year To Date (YTD) daily totals for each S Curve by the Baseline total Man Hours for each Day of the Project.

$$\text{Baseline YTD \%} = \text{Baseline YTD Total} / \text{Baseline Total Man Hours} \times 100\%$$

$$\text{Actual YTD \%} = \text{Actual YTD Total} / \text{Baseline Total Man Hours} \times 100\%$$

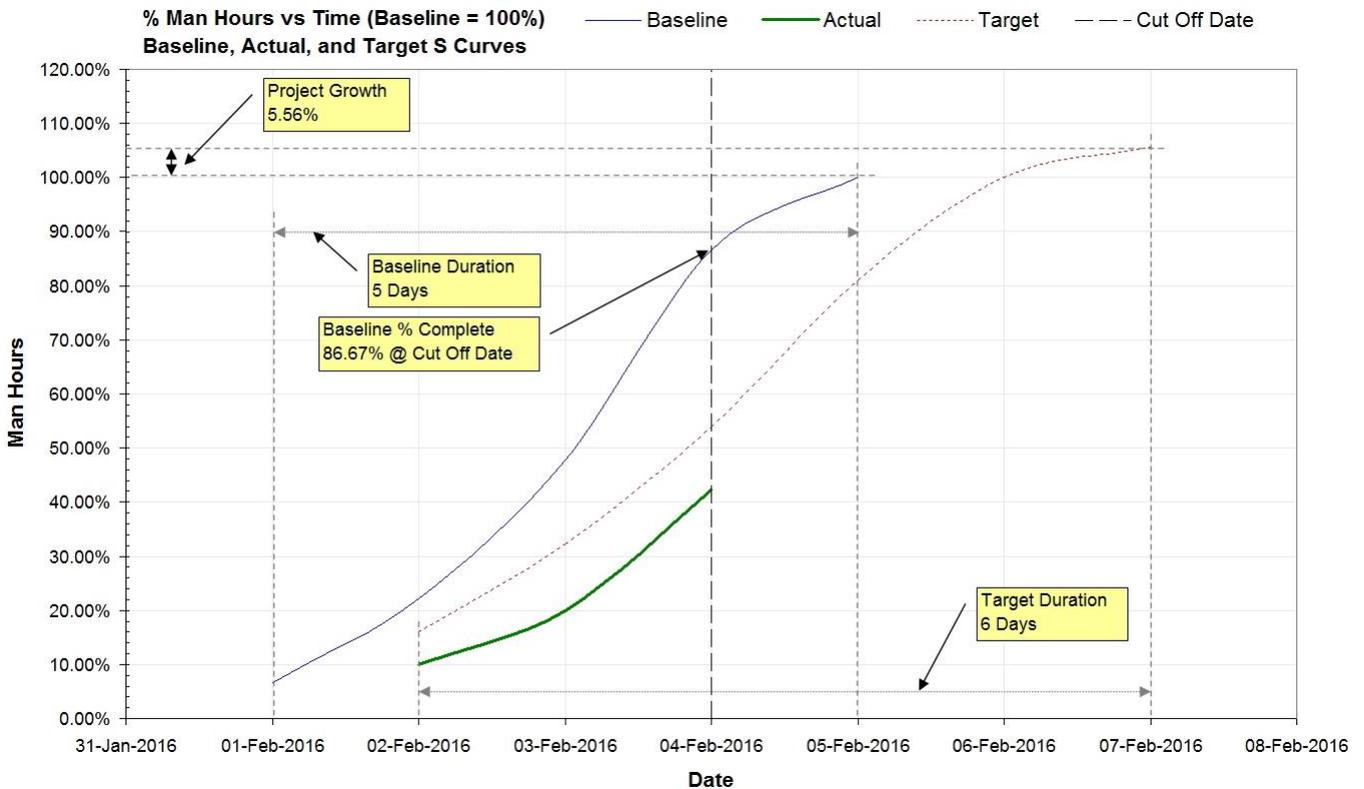
$$\text{Target YTD \%} = \text{Target YTD Total} / \text{Baseline Total Man Hours} \times 100\%$$

The calculations for each S Curve are shown below.

100% Baseline	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016	06-Feb-2016	07-Feb-2016
Baseline YTD	6.0	20.0	43.0	78.0	90.0		
Baseline YTD %	6.67%	22.22%	47.78%	86.67%	100.00%		
Actual YTD		9.0	18.0	38.0			
Actual YTD %		10.00%	20.00%	42.22%			
Target YTD		14.5	29.0	48.5	73.0	90.0	95.0
Target YTD %		16.11%	32.22%	53.89%	81.11%	100.00%	105.56%

**Table 10: Calculation of Percentage S Curves, Baseline = 100%**

The resulting S Curves are shown below.



**Figure 18: Percentage S Curves (Baseline = 100%)**

4.5.2 Generating Percentage S Curves (Target = 100%)

To generate Percentage S Curves with the Target = 100%, divide the Year To Date (YTD) daily totals for each S Curve by the Target total Man Hours for each Day of the Project.

$$\text{Baseline YTD \%} = \text{Baseline YTD Total} / \text{Target Total Man Hours} \times 100\%$$

$$\text{Actual YTD \%} = \text{Actual YTD Total} / \text{Target Total Man Hours} \times 100\%$$

$$\text{Target YTD \%} = \text{Target YTD Total} / \text{Target Total Man Hours} \times 100\%$$

The calculations for each S Curve are shown below.

100% Target	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016	06-Feb-2016	07-Feb-2016
Baseline YTD	6.0	20.0	43.0	78.0	90.0		
Baseline YTD %	6.32%	21.05%	45.26%	82.11%	94.74%		
Actual YTD		9.0	18.0	38.0			
Actual YTD %		9.47%	18.95%	40.00%			
Target YTD		14.5	29.0	48.5	73.0	90.0	95.0
Target YTD %		15.26%	30.53%	51.05%	76.84%	94.74%	100.00%

Table 11: Calculation of Percentage S Curves, Target = 100%

The resulting S Curves are shown below.

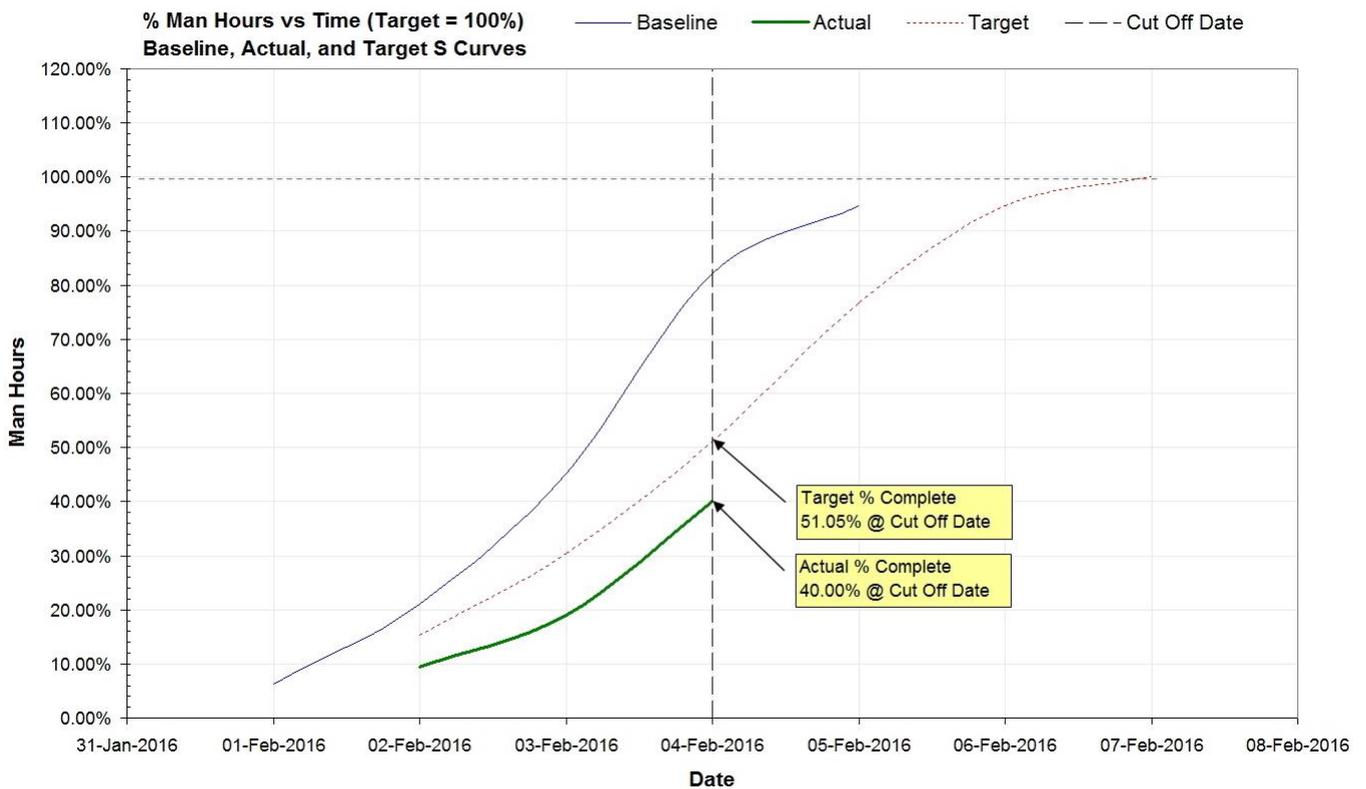


Figure 19: Percentage S Curves (Target = 100%)

### 4.6 Using Task Duration As A Quantity

Extreme caution should be exercised when using Task Duration as a quantity to generate S Curves.

Consider the following Production Schedule.

Task Name	Start	Finish	Man Hours	% Complete	Duration	MH per Day
Task No. 1	01-Feb-2016	05-Feb-2016	10.0	40%	5	2.0
Task No. 2	02-Feb-2016	05-Feb-2016	20.0	30%	4	5.0
Task No. 3	03-Feb-2016	05-Feb-2016	30.0	20%	3	10.0
Task No. 4	04-Feb-2016	05-Feb-2016	140.0	0%	2	70.0
<b>Totals</b>			<b>200.0</b>		<b>14</b>	

Table 12: Production Schedule

The % Complete values represent the Task's physical percentage completion, as inspected on 4th February 2016 (The Cut Off Date).

#### 4.6.1 Task Duration S Curves

The S Curves generated using Task Duration as the Quantity are shown below.

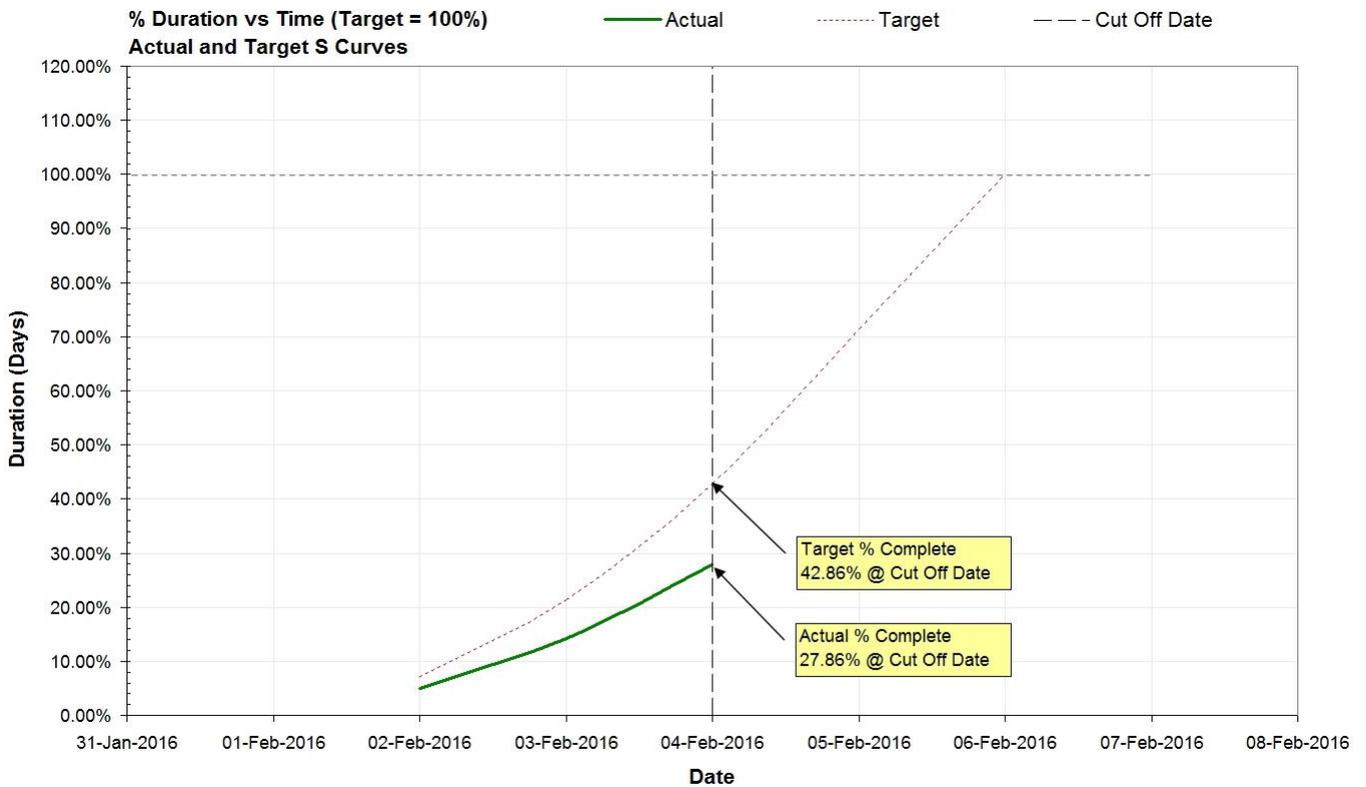


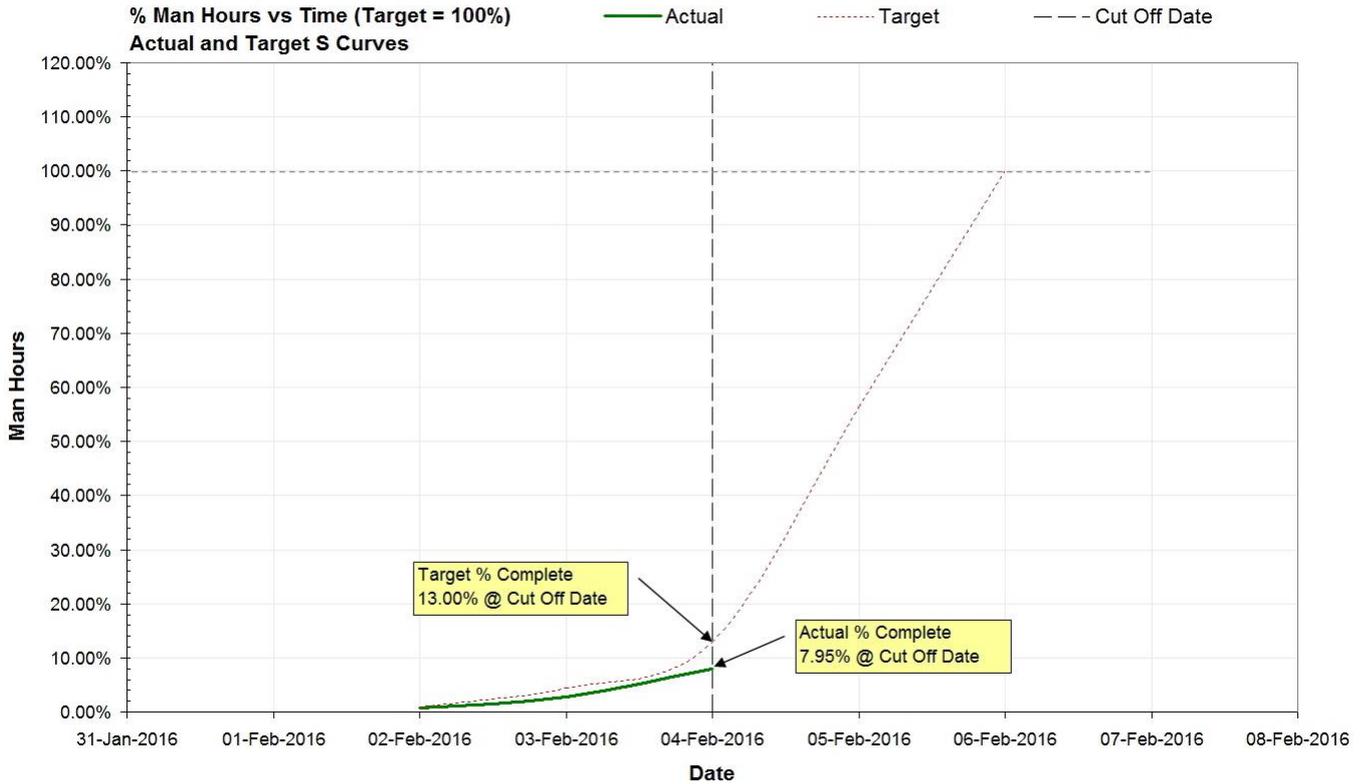
Figure 20: Percentage Task Duration S Curves (Target = 100%)

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Is 27.86% Complete (Actual)
- Should be 42.86% Complete (Target)
- Is 15.00% behind target (42.86 - 27.86)

### 4.6.2 Task Man Hour S Curves

The S Curves generated using Task Man Hours as the Quantity are shown below.



**Figure 21: Percentage Task Man Hours S Curves (Target = 100%)**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Is 7.95% Complete (Actual)
- Should be 13.00% Complete (Target)
- Is 5.05% behind target (13.00 - 7.95)

A comparison of the above figures reveal using Task Duration as a quantity paints a very different picture of the Project's progress as compared to using Task Man Hours as a quantity.

The reason for the variance in the Project's progress is that by using Task Duration as a quantity, the assumption is all Tasks require exactly the same amount of Man Hours per Day. This is often not the case in real life.

### 5.0 Why Use S Curves?

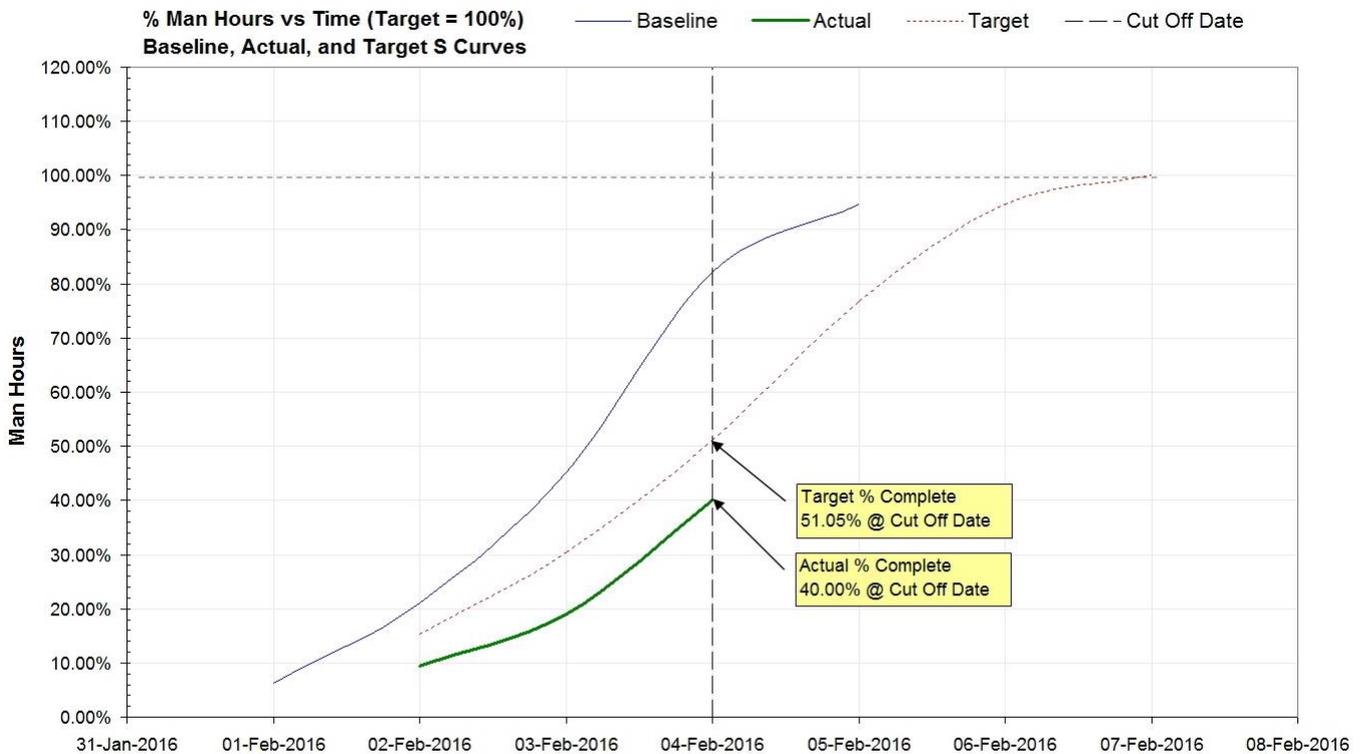
S Curves are an important Project Management Tool. They allow the progress of a Project to be tracked visually over time, and form a historical record of what has happened to date. Analysis of S Curves allows Project Managers to quickly identify:

- Project Progress
- Project Growth or Contraction (Man Hours and / or Cost, Duration)
- Project Start and / or Finish Slippage

Although Gantt Charts also display Project information visually, they can quickly become cumbersome to work with, especially with Projects having hundreds or even thousands of Tasks.

### 5.1 Determining Project Progress

Comparison of Target and Actual S Curves reveal the progress of the Project over time. In most cases, the Actual S Curve will sit below the Target S Curve for the majority of the Project, due to many factors, including under reporting of accurate Task % Complete values, etc. Only towards the end of the Project will the curves converge and finally meet. Although the Actual S Curve may sit above the Target S Curve for a period during the Project, it can never finish above the Target S Curve at Project completion.



**Figure 22: Calculating Project Progress using S Curves**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Is 11.05 % (51.05% - 40.00%) behind target
- Has been behind target since it commenced

### 5.1.1 Ahead Of Schedule?

If the Actual S Curve sits above the Target S Curve, the Production Schedule should be examined to determine if the Project is truly ahead of schedule, or if the Production Schedule contains unrealistic or incorrect % Complete values for ongoing Tasks.

The Target S Curve calculations assume Man Hours and / or Cost will be distributed evenly for each Day of the Task. For example, a Task with a 5 Day Duration and 100 Man Hours will be assumed to be completed at a rate of 20 Man Hours per Day, as shown below.

Target S Curve	5 Days Duration, 100 Man Hours				
Date	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016	06-Feb-2016
Totals Per Day	20	20	20	20	20
YTD Totals	20	40	60	80	100
% Complete	20%	40%	60%	80%	100%

**Table 13: Task Target S Curve Data (Showing Man Hours Distributed Evenly per Day)**

If a Task has the majority of the Man Hours and / or Cost completed at the beginning, in the middle, or at the end of the Task Duration, the Actual S Curve may be pushed higher than the Target S Curve (depending on other Tasks ongoing within the same time period).

The planned Task in the following Table has the majority of the Man Hours scheduled to be completed at the beginning of the Task.

Planned Task	5 Days Duration, 100 Man Hours				
Date	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016	06-Feb-2016
Totals Per Day	35	40	0	15	10
YTD Totals	35	75	75	90	100
% Complete	35%	75%	75%	90%	100%

**Table 14: Planned Task Details**

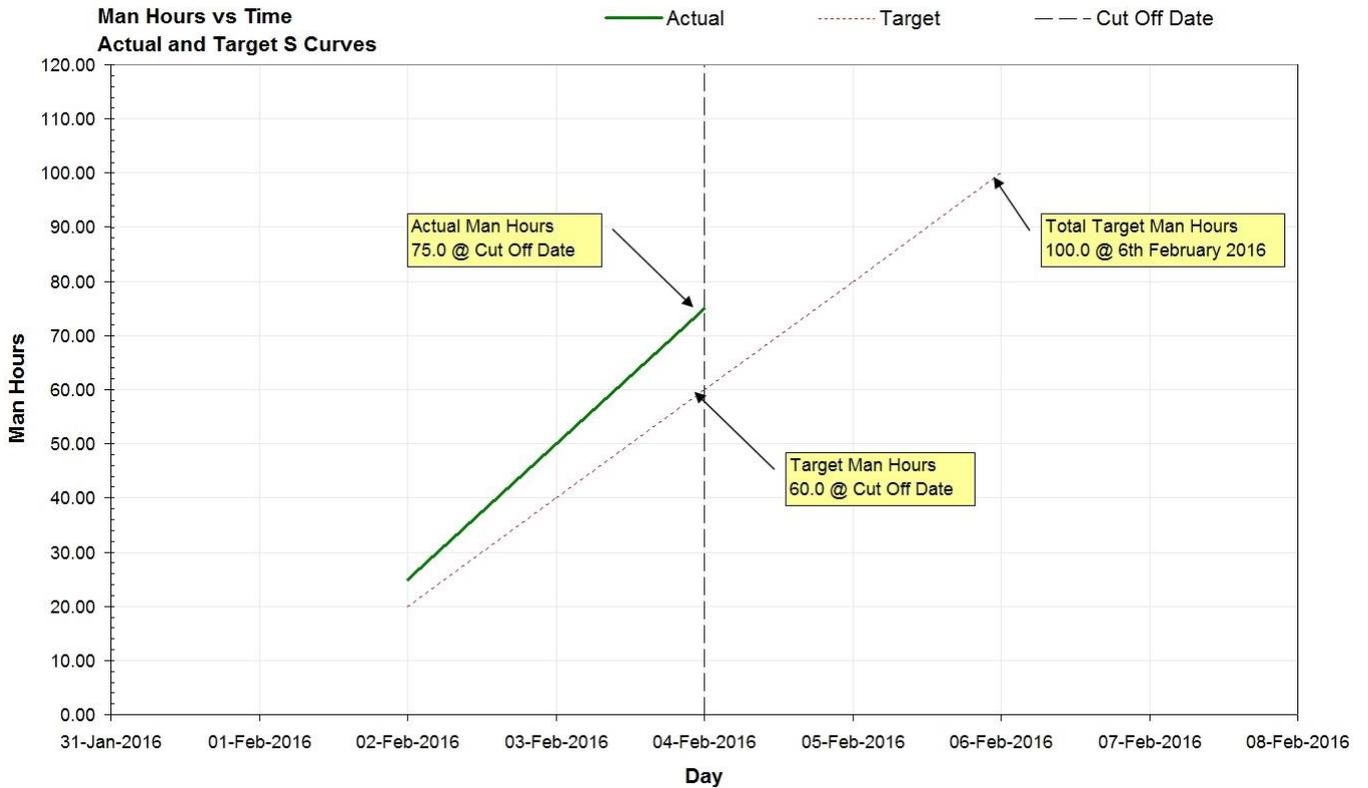
Using a Cut Off Date set to the 4th of February 2016, and a Task % Complete value of 75%, the Actual S Curve calculations for the planned Task are shown below.

Actual S Curve	Cut Off Date: 4th Feb 2016		
Date	02-Feb-2016	03-Feb-2016	04-Feb-2016
Totals Per Day	25	25	25
YTD Totals	25	50	75
% Complete	25%	50%	75%

**Table 15: Task Actual S Curve Data**

5.1.1 Ahead Of Schedule? (Continued)

The following Figure illustrates how such a Task can result in the Actual S Curve sitting above the Target S Curve.



**Figure 23: Actual and Target S Curves (Actual S Curve sits above Target S Curve)**

The accuracy of the Production Schedule and any S Curves generated from it may be improved in this instance by splitting the planned Task into two Tasks.

The original Task should be revised to have a Duration of 2 Days, 75 Man Hours, and be set to 100% Complete.

Revised Task	2 Days Duration, 75 Man Hours, 100% Complete, Cut Off Date: 4th Feb 2016				
Date	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016
Totals Per Day	35	40			
YTD Totals	35	75			
% Complete	46.67%	100%			

**Table 16: Revised Task Details**

A new Task with a Duration of 2 Days, 25 Man Hours, and set at 0% Complete should be added.

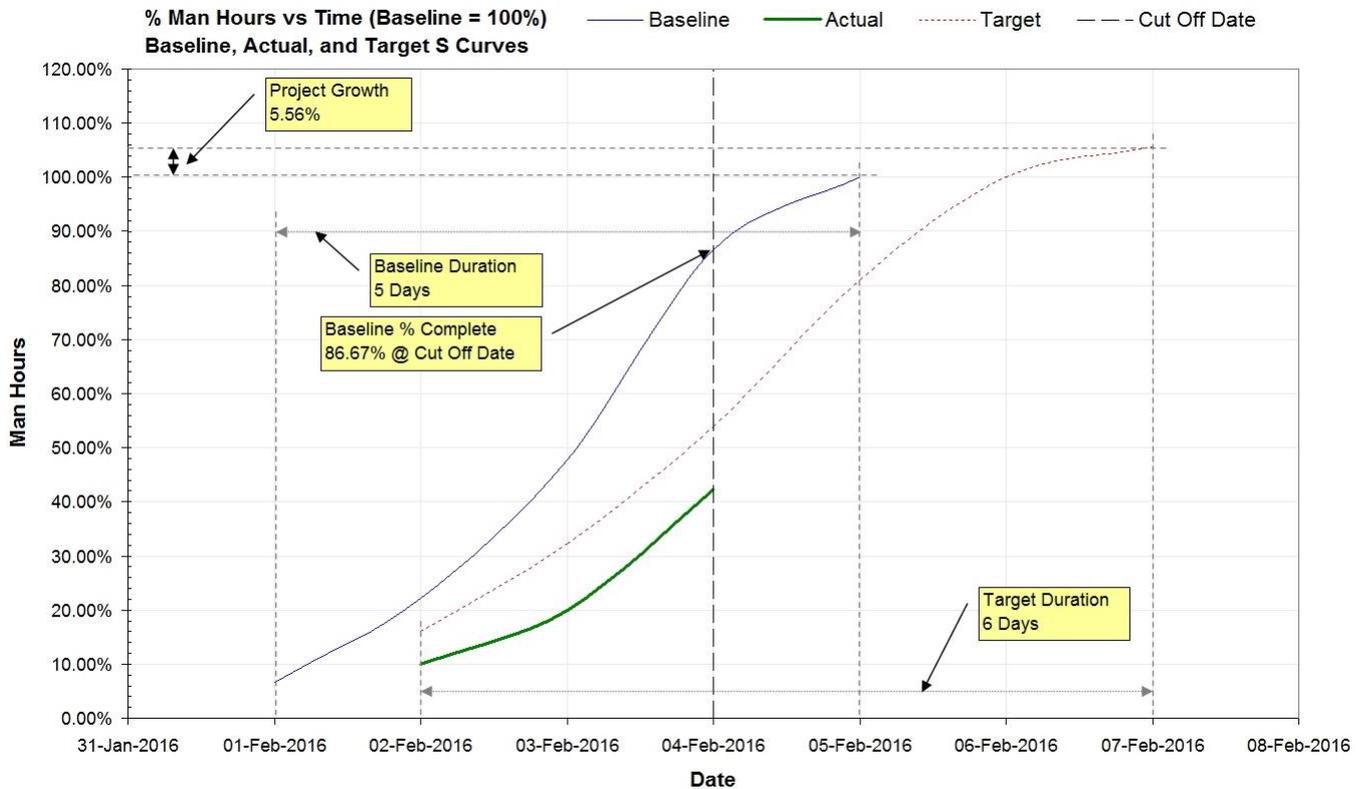
New Task	2 Days Duration, 25 Man Hours, 0% Complete, Cut Off Date: 4th Feb 2016				
Date	01-Feb-2016	02-Feb-2016	03-Feb-2016	04-Feb-2016	05-Feb-2016
Totals Per Day				15	10
YTD Totals				15	25
% Complete				0%	0%

**Table 17: New Task Details**

### 5.2 Determining Project Growth or Contraction

Comparison of the Baseline and Target S Curves quickly reveals if the Project has grown (Target S Curve finishes above Baseline S Curve) or contracted (Target S Curve finishes below Baseline S Curve) in scope.

A change in the Project's scopes implies a re-allocation of resources (increase or decrease), and the very possible requirement to raise contract variations. If the resources are fixed, then the duration of the Project will increase (finish later) or decrease (finish earlier), possibly leading to the need to submit an extension of time claim if the Project will finish late.



**Figure 24: Calculating Project Growth using S Curves**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Has grown in Man Hours by 5.56% (105.56 – 100.00)
- Has grown in Duration by 1 Day (6 Days – 5 Days)

### 5.3 Determining Slippage

Slippage is defined as:

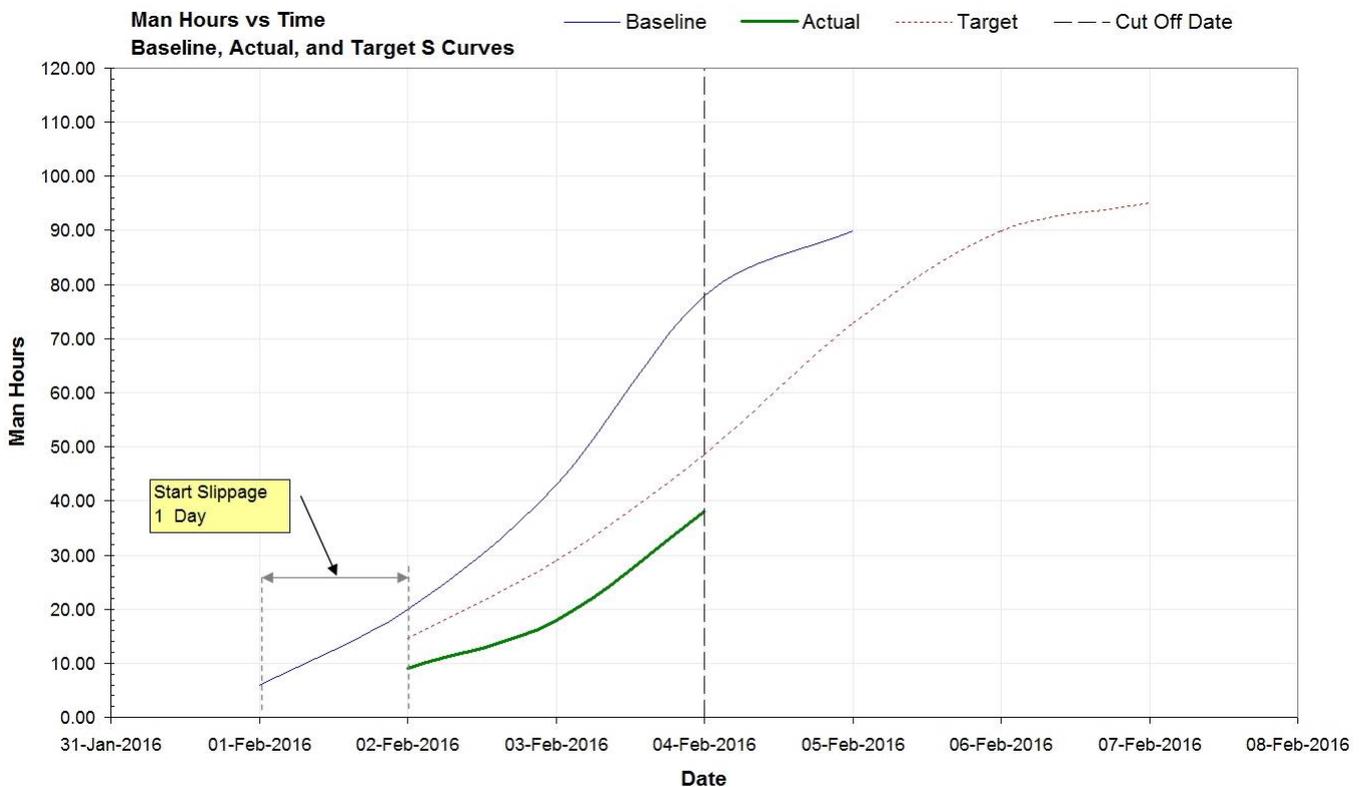
*"The amount of time a Task has been delayed from its original Baseline Schedule. The Slippage is the difference between the scheduled Start Date or Finish Date for a Task and the Baseline Start Date or Finish Date. Slippage can occur when a Baseline Schedule is set and the actual dates subsequently entered for Tasks are later than the Baseline dates or the actual durations are longer than the Baseline Schedule durations".*

**Source:** Wideman Comparative Glossary of Common Project Management Terms v2.1 Copyright R. Max Wideman, May 2001

There are two types of slippage: Start Slippage, and Finish Slippage.

#### 5.3.1 Start Slippage

Start Slippage occurs when the estimated / actual Start Date of the Project / Task is later than the Baseline Start Date. In other words, the Project / Task has started later than planned. If the Project has already commenced, nothing can be done to eliminate or reduce the Project's start slippage. An Extension Of Time Claim and / or Variation may need to be submitted depending on the reasons why the Project started later than planned.



**Figure 25: Calculating Project Start Slippage**

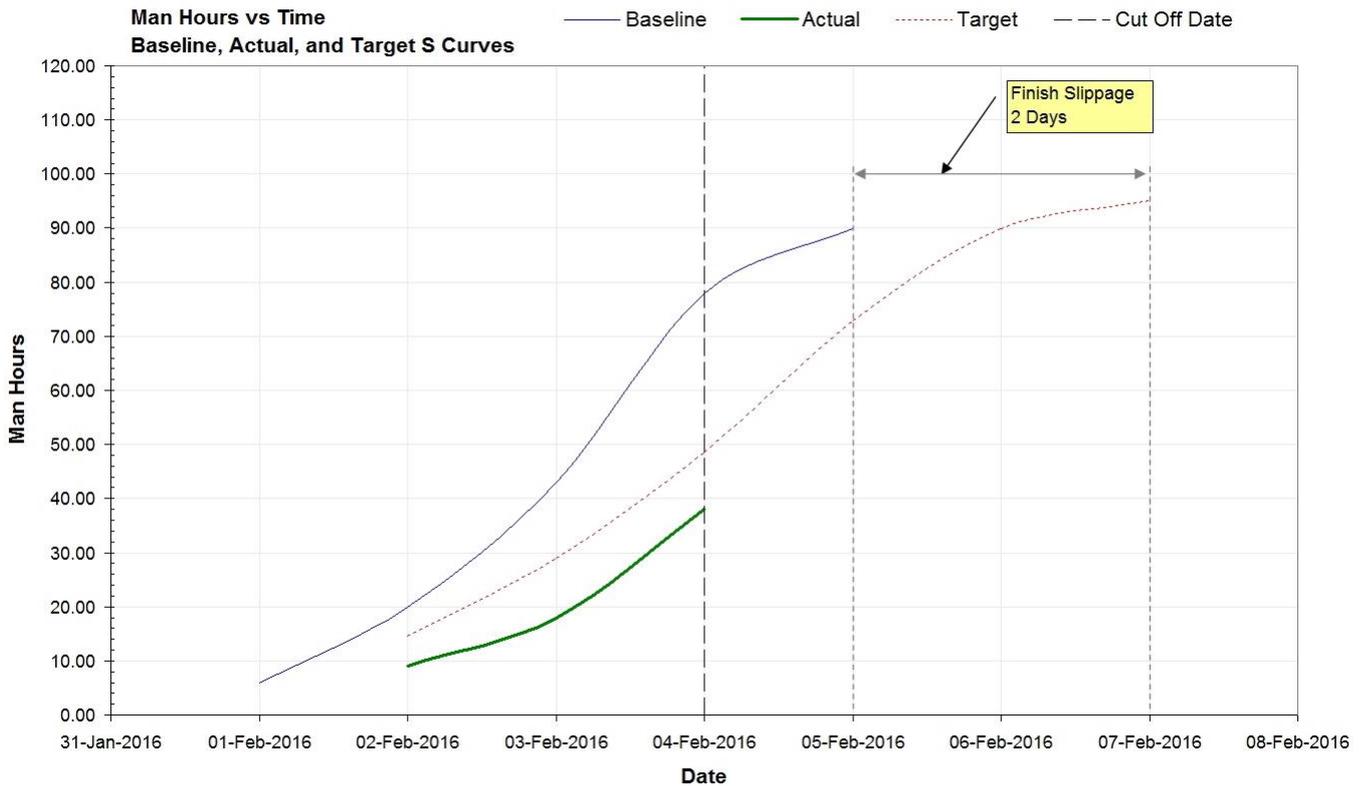
Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Started 1 Day late

### 5.3.2 Finish Slippage

Finish Slippage occurs when the estimated / actual Finish Date of the Project / Task is later than the Baseline Finish Date. In other words, the Project / Task will finish / has finished later than planned, either because the Project / Task started late, or the Project / Task Duration has increased. Obviously if a Project / Task experiences Start Slippage, Finish Slippage will also occur if the Project / Task Duration remains the same. Additional resources will need to be allocated or additional hours worked in order to eliminate (or at least reduce) the Project's Finish Slippage. An Extension Of Time Claim may need to be submitted if the Finish Slippage cannot be eliminated or reduced to an acceptable level.

Comparison of the Baseline S Curve and Target S Curve quickly reveals if Project Start and / or Finish Slippage has occurred. (i.e. the Target S Curve starts and / or finishes to the right of the Baseline S Curve).



**Figure 26: Calculating Project Finish Slippage**

Analysis of the above S Curves reveals the Project as of the 4th of February 2016:

- Will finish 2 Days late

## 6.0 S Curve Analysis

Initial analysis of the S Curves generated above reveal the following about the status of the Project...

- **The progress of the Project is behind target**  
The Actual S Curve sits below the Target S Curve at the Cut Off Date.
  
- **The Project has grown in Man Hours**  
The Target S Curve finishes above the Baseline S Curve.
  
- **The Project has grown in Duration**  
The Target S Curve Duration is longer than the Baseline S Curve Duration.
  
- **The Project has experienced Start Slippage, and thus started later than planned**  
The Target S Curve starts to the right of the Baseline S Curve.
  
- **The Project has experienced Finish Slippage, and thus will finish later than planned**  
The Target S Curve finishes to the right of the Baseline S Curve.

### 6.1 Project Progress

According to MS Project, based on the Production Schedule the Project is 31% complete. MS Project calculates % Complete based on Duration, and does not take into account Man Hours and / or Cost assigned to each Task. Analysis of the Actual and Target S Curve data reveals the Project is 40.00% complete as of the Cut Off Date, while the Project should be 51.05% complete.

$$\begin{aligned} \text{Actual \% Complete} &= \text{Actual YTD Man Hours @ Cut Off Date} / \text{Target Man Hours} \times 100\% \\ &= 38.0 / 95.0 \times 100\% \\ &= 40.00\% \end{aligned}$$

$$\begin{aligned} \text{Target \% Complete} &= \text{Target YTD Man Hours @ Cut Off Date} / \text{Target Man Hours} \times 100\% \\ &= 48.5 / 95.0 \times 100\% \\ &= 51.05\% \end{aligned}$$

### 6.2 Project Growth (Man Hours and / or Cost, Duration)

The Project may grow (or contract) in terms of Man Hours and / or Cost, and in Duration.

#### 6.2.1 Project Growth (Man Hours)

Analysis of the Baseline and Target S Curve data at Project Completion reveals the Project has grown in scope by 5.0 Man Hours, or 5.56% as compared to the Baseline Schedule.

$$\begin{aligned} \text{Project Growth (Man Hours)} &= \text{Total Target Man Hours} - \text{Total Baseline Man Hours} \\ &= 95.0 - 90.0 \\ &= 5.0 \end{aligned}$$

$$\begin{aligned} \text{Project \% Growth (Man Hours)} &= ((\text{Target Man Hours} / \text{Baseline Man Hours}) - 1) \times 100\% \\ &= ((95.0 / 90.0) - 1) \times 100\% \\ &= 5.56\% \end{aligned}$$

### 6.2.2 Project Growth (Duration)

Growth in the Project's Duration may be determined by comparing the Baseline Duration with the Target Duration.

Analysis of the Baseline and Target S Curve data reveals the Project has experience a growth in Duration of 1 Day, or 20.00% as compared to the Baseline Schedule.

$$\begin{aligned} \text{Project Growth (Duration)} &= \text{Target Duration} - \text{Baseline Duration} \\ &= 6 \text{ Days} - 5 \text{ Days} \\ &= 1 \text{ Day} \end{aligned}$$

$$\begin{aligned} \text{Project \% Growth (Duration)} &= ((\text{Target Duration} / \text{Baseline Duration}) - 1) \times 100\% \\ &= ((6 \text{ Days} / 5 \text{ Days}) - 1) \times 100\% \\ &= 20.00\% \end{aligned}$$

### 6.3 Project Slippage

The Project may experience Start Slippage (starting later than planned) and / or Finish Slippage (finishing later than planned).

#### 6.3.1 Project Start Slippage

Analysis of the Baseline and Target S Curve data reveals the Project has a Start Slippage of 1 Day, or 20.00% as compared to the Baseline Schedule.

$$\begin{aligned} \text{Start Slippage} &= \text{Target Start Date} - \text{Baseline Start Date} \\ &= 2^{\text{nd}} \text{ Feb 2016} - 1^{\text{st}} \text{ Feb 2016} \\ &= 1 \text{ Day} \end{aligned}$$

$$\begin{aligned} \text{Start Slippage \%} &= \text{Start Slippage} / \text{Baseline Duration} \times 100\% \\ &= 1 \text{ Day} / 5 \text{ Days} \times 100\% \\ &= 20.00\% \end{aligned}$$

#### 6.3.2 Project Finish Slippage

Analysis of the Baseline and Target S Curve data reveals the Project has a Finish Slippage of 2 Days, or 40.00% as compared to the Baseline Schedule.

$$\begin{aligned} \text{Finish Slippage} &= \text{Target Finish Date} - \text{Baseline Finish Date} \\ &= 7^{\text{th}} \text{ Feb 2016} - 5^{\text{th}} \text{ Feb 2016} \\ &= 2 \text{ Days} \end{aligned}$$

$$\begin{aligned} \text{Finish Slippage \%} &= \text{Finish Slippage} / \text{Baseline Duration} \times 100\% \\ &= 2 \text{ Days} / 5 \text{ Days} \times 100\% \\ &= 40.00\% \end{aligned}$$

#### **6.4 Project Summary**

The Project's progress to date (i.e. the Cut Off Date) is behind target compared to both the Production and Baseline Schedules. The Production Schedule may need to be reviewed to ensure Tasks have been updated accurately (especially with respect to true % Complete values), and ongoing and future Tasks may require rescheduling.

The Project has grown in scope and will finish over budget. Project growth may be due to a number of factors, including underestimation of effort in the Baseline Schedule, low productivity, rework, variations (approved or not), unexpected weather or other delays, etc. In this example, variations may need to be raised to account for the extra Man Hours.

The Project has grown in Duration, started late, and will finish late compared to the Baseline Schedule. Project Duration growth, and Start / Finish Slippage may be due to a number of factors, including unexpected delays, low productivity, rework, variations (approved or not), etc. In this example, a Claim for an Extension Of Time and / or Excusable Delay may need to be raised for the later than planned start and / or completion dates.

In summary a detailed analysis of the Project is required to determine why the Project will be completed late and over budget as currently scheduled.

### 7.0 Generating S Curves

Some software scheduling packages may automatically generate S Curves. On the other hand, some (including MS Project) do not. In this case, a third party software application is the ideal solution to process the Baseline and Production Schedule data to generate the required Project Statistics, Task Statistics, S Curves, and Histograms.

Midori Media's myPM SCG Enterprise is an MS Windows application that integrate with supported versions of MS Excel (2000, 2002, 2003, 2007, 2010, 2013, 2016, 2019, 2021) and MS Project (2000, 2002, 2003, 2007, 2010, 2013, 2016, 2019, 2021) to generate Project Statistics, Task Statistics, S Curves, and Histograms.

myPM SCG Enterprise processes Tasks contained in the Data Source File, and creates an MS Excel Output File containing the required Project Statistics, Task Statistics, S Curves, and Histograms. These may be copy-pasted to MS Word for inclusion in Project Progress Reports.

### 8.0 Conclusion

The S Curve is an important but often overlooked and misunderstood Project Management Tool. Although a variety of S Curves exist, the most common are Man Hours versus Time and Cost versus Time.

By creating a Baseline Schedule, a Baseline S Curve may be generated. Baseline S Curves provide a basis on which to compare a Project's actual status to its planned status. They may also assist in the planning of Man Power and financial resources required to complete the Project.

A Production Schedule allows Actual and Target S Curves to be generated. These allow the progress of a Project to be monitored, and quickly reveal any divergence from the Baseline Schedule. S Curves may be used to determine Project progress to date, growth (Duration, Man Hours and / or Cost), and Start and / or Finish slippage.

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